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FOR PROMOTING EXPERIMENTS IN
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RESEARCH STATION
KENT

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CONTENTS

PAGE

COMMITTEE 5

STAFF 8

EDITORIAL AND INTRODUCTORY 10

SECTION I

THE EXPERIMENTAL FARM 11

SECTION II

GENERAL REVIEW OF RESEARCH WORK 21

SECTION III

PRELIMINARY RESEARCH REPORTS 47

Notes on Certain Plant Diseases observed in 1931. H. WORMALD and R. V. Harris 47

Notes on Insect Pests for the Year 1931. A. M. MASSEE 51

Weather Conditions during 1931. H. C. CHAPELOW and H. M. TYDEMAN .. 55

SECTION IV

BULLETINS FOR FRUIT GROWERS 57

POMOLOGY

Some Aspects of Morello Cherry Culture. N. H. GRUBB, A. C. PAINTER and H. WORMALD 57

The Pruning and Renovation of Apple Trees. N. H. GRUBB 61

The Planting Situation. N. B. Bagenal 67

PAGE

MYCOLOGY

Bacterial Canker of Plum Trees. H. WORMALD 70

Some Fundamental Considerations Regarding Successful Control of Apple Scab. M. H. MOORE 73

ENTOMOLOGY

A Simple Method of Forecasting Insect Attacks in Orchards Previous to the Spraying Season. A. M. MASSEE 78

The Control of the Raspberry and Loganberry Beetle by Means of Derris. W. STEER 81

PUBLICATIONS

List of Published Reports 85

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Visits may be paid to the Research Station on any week day *by appointment* (Saturday afternoon only under exceptional circumstances).

Passenger Station: East Malling Halt. Southern Railway.

Goods Station: Aylesford.

Bus Services by the Maidstone and District Bus Co., every 20 minutes from Maidstone to East Malling Church.

Ditton Corner on the main London—Maidstone Road (with Red Lamp Danger Signal) is the turning to the Research Station for visitors coming by road.

Telephones: The Station is now served by two lines:
Research Station, *Administrative*—(Aylesford 7229).
Research Station, *Advisory and Technical Service*—(Aylesford 7189).

EDITORIAL AND INTRODUCTORY

In the past it has been customary for a statement of the Station's general development and activities to be presented by the Executive to the Annual General Meeting and sent not only to our Associate Members but used for general circulation. Owing to the need for drastic economies it has been decided from now onwards to print this statement as a supplementary pamphlet for the use of our Committees and Members only, and to issue an Annual Report of Research Work to be made up of four sections as follows :—

I. The Experimental Farm.
II. General Review of Research Work.
III. Preliminary Research Reports.
IV. Bulletins for Fruitgrowers.

Thus the two parts (I. General and II. Supplement) of the Annual Report previously issued will now be more or less merged into a single volume, and the details of administrative and extension activities circulated separately to our Members as explained above.

In some years one section of the volume will be liable to be more amplified than another, according as the activities of the Research Staff vary. To this volume all our Associate Members will be entitled.

Section I

THE EXPERIMENTAL FARM

THE FARM

By J. AMOS, F. H. BEARD, and A. C. PAINTER, with introduction by R. G. HATTON.

Introductory.

The total area of the Research Station is now approximately 120 acres (Great East Field 22 acres, Egham Field 40 acres, Church Fields 20 acres, Newgates Field 25 acres, and Upper Grub and Newgates Shaw 13 acres). However, quite a considerable proportion of the area (approximately 10 acres) is occupied by buildings, approaches, innumerable headlands to comparatively small experimental plots and even to planted areas which can never be commercially productive (approximately 6 acres). In addition, many of the plantings (approximately 40 acres) are still quite young and are producing no returns. Again, varieties of problematical commercial value have frequently to be deliberately chosen for planting in order to study the very troubles for which the grower is seeking an explanation. Finally, even amongst the yielding areas there are inevitably the " control " plots, the unpruned, unsprayed, unmanured, etc., which bring down the standard of the whole. The picking and marketing is often complicated by the very large number of varieties grown and the small plots into which many of the trials are divided, e.g. the main strawberry and raspberry trials in Church and Newgates Fields consist of some 350 and 200 plots respectively, each of which has to be picked and recorded separately, thus appreciably increasing the cost of picking and the amount of handling, which, in its turn, renders it difficult to get the fruit on to the market in the best condition.

Owing to all these experimental exigencies it is only on comparatively small areas that our own ideal routine of cultural and spraying methods can be carried out. We would ask our grower readers to bear all these foregoing facts in mind in judging the results on an experimental farm. East Malling must not be looked at as a farm mainly demonstrating how things should be done ; only too often the right ways can only be found out after eliminating a succession of wrong ones, and it yet remains for some Educational Authority to demonstrate on a commercial scale the combination of right findings of research, and put them in their economic frame. This point of view is being emphasized because we believe that our annual report on the farm could profitably be developed in more detail than heretofore, provided it is realized that we are not claiming to tell the story of a commercial holding run on up-to-date lines.

General.

Apart from February, which was wet and cold, the early part of the year was ideal for outdoor operations, the weather being dry and " open." Showery and mild conditions during April and May, followed by higher temperatures during the greater part of June, were very favourable to the growth of soft fruits. On the other hand, inclement weather at the end of May and the first few days of June made it difficult to apply the first post blossom scab spray at the correct time. The result of this delay was reflected in some instances, in indifferent control of apple scab. In the main, however, a good control was obtained by carrying out our usual routine spraying programme (see appendix p. 19). July and August were dull and wet and temperatures low. Whilst the

frequent rains prolonged the soft fruit season, they interfered considerably with the gathering of the crops, and made harvesting operations in general particularly difficult. Conditions during September, although showing some improvement, were generally similar to those prevailing in July and August. The latter part of the year was notably fine, dry and very mild.

MARKETING.

Last year's experience went to confirm the opinion already formed in previous years as to the vital importance of careful picking, grading, and marketing, and, with the exception of such fruits as currants, practically every variety is now graded either at the time of picking or afterwards in the packing shed. It is, however, quite realized that where very large quantities of fruit have to be dealt with, the whole question of the special organization required to handle fruit by these methods would have to be carefully considered.

Wherever graded and ungraded fruit was marketed together the prices returned were always to the detriment of the latter.

A feature in the case of the later varieties of both apples and pears was the early ripening of the fruit on the tree in spite of the dull, cool weather conditions, and its poor keeping quality in store compared to a normal year.

INDIVIDUAL CROPS.

Strawberries. At present some $7\frac{1}{2}$ acres in Church Fields are laid down to strawberry trials (strain, time of planting, etc.), $2\frac{1}{2}$ acres of which during the period under review were in their 4th year, 2 acres in their 3rd, $1\frac{1}{2}$ acres in the 2nd and $1\frac{1}{2}$ acres in their first, these last not having yet come into cropping.

The above consists almost entirely of Royal Sovereigns, a small area being given up to a collection of varieties.

From the 6 acres in bearing rather over 10 tons of fruit were picked, mainly of good size and quality, for which a gross return of some £470 was received.

The Royal Sovereigns gave a yield of approximately $9\frac{1}{2}$ tons, about 50 per cent. of which was marketed under the National Mark Scheme, some 2,700 lbs. as " Extra Selected " and 7,000 lbs. as " Selected."

Except for odd consignments at the commencement and end of the season, prices for the " Extra Selected " fruit ranged from 8d. to 1s. a lb. and the " Selected " from 4d. to 8d. Small and jam fruit was marketed in 6 lb. chips or tubs at prices ranging from 3d. to 4d. a lb.

With a view to testing the value of grading, consignments were sent up on two occasions consisting of :

(1) Fruit picked to National Mark requirements, i.e.,
  (a) " Extra Selected " (marketed in 1 lb. punnets),
  (b) " Selected " (marketed in 3 lb. chips),
  (c) Fruit below National Mark Standard (marketed in 6 lb. chips or tubs).

(2) Fruit picked from the same beds but not graded, except to exclude very small and jam fruit, and marketed in 3 lb. chips.

As can be seen from the following table, in the first case, the graded fruit made a net return, after paying all picking and marketing expenses, of $4\frac{1}{4}$d. a lb. against $2\frac{1}{4}$d. for the ungraded, and in the second, when the proportion of " Extra Selected " fruit was very considerably less, $3\frac{3}{4}$d. a lb. against 3d. The season was then too far advanced for further trials to be made, but it is proposed to continue them during the coming summer. This would seem to point to the fact that to grade and market the fruit under the National Mark it must be of sufficiently good a standard.

	1st Picking.		2nd Picking.	
	Graded.	Ungraded.	Graded.	Ungraded.
Amount	455 lbs.	428 lbs.	570 lbs.	667 lbs.
	d.	d.	d.	d.
Average Gross Price	6.98	4.9	5.98	5
Picking, Packing and marketing expenses	2.73	2.67	2.34	2.11
Net Average Return	4.25	2.23	3.64	2.89

Raspberries. The total area under raspberries consists of some 11½ acres, comprising 1½ acres of variety trials in Egham Field, and 5 acres of Lloyd George and 5 acres of Pyne's Royal in Newgates. Of these, 4 acres of Lloyd George and the whole of the Pyne's Royal have been utilized for the past three years for a manurial trial. The total pickings amounted to 16½ tons and the gross receipts to £460.

The great bulk of the crop, viz. some 15 tons, was obtained from the two varieties on Newgates Field, the Lloyd George contributing by far the greater share, viz. some 12 tons, and the Pyne's Royal a little short of 3.

The fruit, although on the small side, was noticeably free from maggot so prevalent in previous years, freedom from this pest being attributed to two sprayings with a wash containing Derris when in flower (see appendix and article "Control of the Raspberry and Loganberry Beetle by Means of Derris," by W. Steer).

Prices for the second year in succession ruled low, and except where it was necessary to pick for experimental reasons, much of the later fruit was left ungathered. For the same reason the greater proportion of the crop was marketed for jam. The actual approximate amounts marketed in chip baskets and tubs were as follows :

1 lb. punnets	2,700 lbs.
3 lb. chips	7,000 lbs.
Tubs	27,000 lbs.

Punnet fruit fetched from 6d. to 8d. and chip fruit from 4d. to 6d. a lb. The price for jam fruit started at £25 a ton and steadily dropped until it reached the low level of £16.

Gooseberries. The variety collection of gooseberries consisting of Careless, Freedom, Greengage, Gunner, Keepsake, Leader, Leveller, White Lion and Whitesmith comprises two acres of bushes interplanted between bush pear trees and ranging from eleven to three years old. Of this half an acre is not yet in bearing.

These were thinned when green, with the exception of Whitesmith (which it has been found does not pay to leave for dessert) with a view to the production of good sized dessert fruit, the larger proportion at the end of May and early June, and the remainder about the middle of the month. Berries were left about one inch apart, the smaller fruit being removed. In the case of Whitesmith, the larger berries were picked. Just under 2 tons of thinnings were marketed, which yielded approximately £48 gross. Generally speaking, this method of thinning just about paid for itself.

The resultant crop of dessert fruit, however (omitting Whitesmith) amounted to some 4⅓ tons and gave a gross return of £120. All the fruit was graded and marketed as follows :

" Selected " (25 to 30 berries to the lb.)—2,200 lbs. in 6 lb. chips.

These fetched 3d. to 5d. a lb. gross according to variety, the yellow ones in all cases commanding a higher price than the white.

Grade I (35 to 40 berries to the lb.)—3,900 lbs. in 12 lb. chips. Price 2½d. to 4d. a lb.

Grade II (45 to 55 berries to the lb.) 2,450 lbs. in 12 lb. chips. Price 1½d. to 3d. a lb.

Smalls 1,200 lbs. mainly in half-sieves. Price 1½d. to 2d. a lb.

This works out at approximately 3d. a lb. gross which it is thought must be considered satisfactory in view of the heavy crops.

Red Currants. Red Currants, together with a small number of White Currants, interplanted between bush apple trees, cover about ¾ acre, and include some twenty varieties.

The crop amounted to 2¾ tons and yielded a gross return of £80. The fruit was marketed in 6 lb. chips and fetched from 2½d. to 5d. a lb.

The White Currants had, in the main, to be left unpicked, the few chips that were sent to market, although of good quality, either fetched next to nothing or remained unsold, there apparently being no demand for this fruit.

Black Currants. The 6 acres of Baldwins in Newgates Field (planted at 6 by 4), now in their 6th year, produced nearly 28 tons of fruit, while the yield from the 3¼ acres of mixed varieties in Egham Field and Great East was somewhat over 6 tons.

With the exception of some 2 tons, the entire crop from Newgates Field was sold by contract, approximately half at £18 and half at £20 5s. per ton on the field, picked into buyers' empties, and brought in £570.

That from Egham Field and Great East was sent to the markets in the usual way in 6 lb. chips and yielded some £175 gross at prices ranging from 2½d. to 4d. a lb.

The New Seedlings raised at East Malling by Captain Wellington and grown side by side with the main commercial varieties all produced comparatively heavy crops and promise well, the fruit being of bold appearance and good quality.

Wellington's	Triple X	gave	4.9	tons	per	acre
,,	Double X	,,	3.8	,,	,,	,,
,,	One X	,,	3.0	,,	,,	,,

whilst Baldwin, which cropped the heaviest of the other varieties, produced 4 tons per acre. Goliath yielded 1.8 tons, French and Seabrook's 1.7 tons and Boskoop Giant 1.5 tons per acre.

Cherries. The eight year old Morellos, which cover .4 of an acre, again cropped heavily and together with the five year old trees, which gave their first crop, yielded a total of a little over 3½ tons of marketable fruit. Owing to the wet, there was a good deal of cracked fruit, otherwise this total would have been rather larger.

The fruit was graded into two size grades and marketed in 6 and 12 lb. chips, the larger size grade (45 to 55 cherries to the lb.) which amounted to 5,400 lbs., fetching from 4d. to 7d. a lb. and the small size grade (55 to 65 to the lb.), of which there were some 2,500 lbs., from 3d. to 5d., the total gross return being £155 or 4¾d. a lb.

None of the other cherries have yet come into bearing.

Plums. After the heavy crop of the previous season, plums were patchy.

In all, some 12 tons of fruit were picked from the 8 acres in bearing (realizing £410), mainly Victorias and Czars, with smaller quantities of Myrobolan, Pershore Egg, Purple Egg and Warwickshire Drooper, etc. This latter variety, coming in as it does during the second half of September, is of considerable value in extending the season and always finds a ready market.

All varieties were graded into three and some into four size grades, the better class fruit being marketed in 12 lb. chips and the remainder in half-sieves.

With the short crop, prices ruled firm throughout the season, ranging from 6s. a 12 lb. chip for Selected Victorias and Gage Plums, down to 3s. 6d. and 4s. a half-sieve for " small " Czars and Pershore Egg.

The Myrobolans once more cropped heavily and that in spite of damage from Tar Distillate spray which drifted on to them when neighbouring trees were being washed.

This tree would appear to be eminently suitable as a windbreak and might well be utilized in place of the Damson, which it is so often the custom to employ. It would seem to have the following points in its favour :

(1) It forms a large, thick, bushy head.

(2) It is not subject to aphis attack and consequently does not need spraying.

(3) It is capable of bearing heavy crops and though it blossoms early and is therefore liable to be caught by frost, it by no means follows that it will usually fail to produce a crop. This is borne out by the record given below of trees planted in one of the plum stock trial plots at the Station. From this it will be seen that they have only once failed to crop since first coming into bearing in 1926. The trees are planted at 15 feet apart on five different rootstocks, and are now eleven years old.

CROP RECORD OF MYROBOLANS (RED CHERRY PLUM).

(Planted Feb., 1921.)

Year.	Total No. of Trees.	Average Yield per Tree.	Gross Price per lb.	Gross Return per Tree.
		lbs.	d.	£ s. d.
1921 to 1925	29	Nil	—	— — —
1926	29	6	4.2	2 1
1927	29	Nil	—	— — —
1928	29	45	6.0	1 2 6
1929	29	110	3.45	1 11 6
1930	26	123	3.2	1 12 9
1931	26	152	3.6	2 5 6

As with strawberries, preliminary trials of graded and ungraded plums in the form of small consignments of Early Rivers and Czars were sent to market on some six occasions. In every case the graded fruit fetched an appreciably higher price, viz. from 5d. to 1s. 2d. a half-sieve—more than the ungraded, amply covering any extra grading cost involved, which should not in any case exceed a maximum of 2d. per half-sieve.

The quantities admittedly were only small, amounting as they did to some sixty half-sieves of each, but the fact is placed on record with a view to encouraging growers to try out the matter for themselves, as it would seem that there is a very definite demand for the better graded fruit.

Pears. There are 4 acres of pears from twelve to five years old consisting of a number of different varieties.

With the possible exception of Conference, all these have yet to yield their first full crop. Blossom was scarce and for most varieties the year was a blank one, Conference again being the only one to yield any appreciable amount of fruit accounting for some 100 bushels out of a total crop of 210. The gross return on these amounted to some £110.

Apples. Twenty-three acres in all are planted up with apples, which provide the greater bulk of the fruit grown at the Station. Seven acres of this consist of young

trees that have not yet come into cropping. The main varieties grown are Bramley's Seedling, Worcester and Lane's Prince Albert with smaller quantities of Cox, Allington, Newton, Grenadier, Derby, James Grieve and Early Victoria. In all there are now well over 120 varieties grown on the Station in one way or another.

The total marketable crop (including thinnings and dropped fruit) amounted to approximately 3,400 bushels and brought in a gross return of £1,300.

The crops from most varieties were not heavy. In the case of a good number, and particularly in that of Bramley's Seedling, this was mainly due to lack of blossom, the trees being in their " off " year. The principal yields were as follows :

Worcester	2½ acres	610 bushels
Bramley's	2½ acres	590 ,,
Lane's	2⅔ acres	530 ,,

(With the exception of ⅓ of an acre of Worcesters, which are eighteen years old, the majority of the above are twelve year planted trees. In all cases the plant is 15 by 15.)

Where feasible the fruit was graded and marketed under the National Mark Scheme. As this has now been done for the past four years, the following tables, giving an analysis of the Worcester and Bramley crops under the different National Mark and other quality grades, are of interest. Figures are given over a four year period in the case of the Bramleys and for three years in the case of the Worcesters :

TABLE I.

WORCESTERS.

	1929. Bushels.	%	1930. Bushels.	%	1931. Bushels.	%	Totals (3 years). Bushels.	Average.
								%
" Extra Fancy "	123	19	59	16	84	14	266	16.0
" Fancy "	322	50	179	48	236	38	737	45.0
" C " Grade Standard	127	19	82	22	192	32	401	24.0
Smalls (under 2" size, all quality grades)	52	8	21	5	55	9	128	7.3
Culls	24	4	35	9	41	7	100	6.6
Totals ..	648		376		608		1,632	

TABLE II.

BRAMLEYS.

	1928. Bushels.	%	1929. Bushels.	%	1930. Bushels.	%	1931. Bushels.	%	Totals (3 years). Bushels.	Average.
										%
" Fancy " (includes " Extra Fancy ")	389	74	518	45	610	59	317	54	1,834	58.0
" C " Grade	69	13	364	31	181	17	131	22	745	21.0
Smalls (under 2½" size, all quality grades)	61	11	190	16	167	16	62	11	480	13.0
Culls (over 2½" size) ..	13	2	92	8	83	8	77	13	265	8.0
Totals ..	532		1,164		1,041		587		3,324	

The Bramley fruits were thinned to singles throughout in each year except for a few trees in a fruit thinning experiment. The Worcesters were not thinned.

In the case of both Worcester and Bramley, of the 5 acres involved, 1⅓ acres consist of a plot from which all manure had been withheld until 1931, and which has produced fruit appreciably smaller in size and more scabby than that on the other plots.

One of the main causes of relegation of fruit to the " C " grade standard in the case of the Worcesters has been lack of colour, and, in this connection, it may be stated that a higher standard of colour has been employed for the "Fancy" grade than that laid down by the regulations, viz., about 25 per cent. instead of 10 per cent.

The somewhat appreciable fall in the proportion of " Extra Fancy " and " Fancy " Worcesters in 1931 may be partly accounted for as follows :

(*a*) The trees were picked over twice in 1929, three times in 1930, but in the case of the great majority only once in 1931. As a consequence, in this latter year a quantity of fruit which might have coloured up sufficiently to be marketed under the " Extra Fancy " or " Fancy " grades had it been left on the trees had, owing to lack of colour, to be relegated to " C " grade standard.

(*b*) On certain of the plots, the Worcesters are beginning to be unduly shaded by the Bramleys, which is probably materially affecting the colour.

(*c*) 1931 was mainly a sunless year.

(*d*) On the other hand, against this has to be set the fact that two plots were grassed down in the spring of 1931 and produced some very highly coloured fruit.

" Extra Fancy " Worcesters in boxes and half-sieves fetched from 12s. to 15s. a bushel, " Fancy " from 10s. to 12s. and " C " grade in half-sieves from 7s. to 11s. according to size.

The greater part of the Bramley crop amounting to some 350 bushels was box packed and placed in cold store, being marketed in February and March. Prices ranged from 9s. for counts as high as 200 to 14s. for the larger sized fruit in the case of the " Fancy " grade, and 8s. to 11s. a bushel in the case of the " C " grade fruit.

A quantity of Allingtons from one of the grassed down plots were also packed in half-boxes and half-sieves and similarly stored. This fruit kept remarkably well, improving both in appearance and flavour, and was still in excellent condition when marketed in February and March.

The Belle de Boskoop crop which included a quantity of clean and highly coloured fruit was also box packed and placed in cold store. This variety, however, would appear to be susceptible to Scald, and when it was examined in the middle of January a considerable proportion of the fruit was found to be affected to some degree.

There was considerable russeting of the fruit in the case of the Lanes, the blemish being of such an extent as to preclude its being marketed under the National Mark Scheme. It is difficult to account for this as the trees were only sprayed once with Lime-sulphur at 1 in 30 plus Arsenate of Lead before blossoming, and with a Nicotine and Soft Soap wash after petal fall.

Apple Blossom Weevil (*Anthonomus Pomorum* [L.] Curt.) was particularly troublesome and did considerable damage even on trees that produced much blossom. Traps of corrugated cardboard, when removed later in the season, were found to contain very large numbers of the weevil.

A slight attack of Apple Capsid (*Plesiocoris Rugicollis* Fall.) called for stringent measures and two thorough sprayings of a strong Nicotine wash were applied. Apple Sawfly (*Testudiuea Hoplocampa* Cam.) did little damage except on plots where the Nicotine and post blossom Lime-sulphur sprays were omitted.

The plots of apples grassed down in 1930 afforded a striking example of the effect of grass on the size and colour of the fruit and general appearance of the trees. Whilst the size of the fruit was somewhat smaller than that on the cultivated plots, the colour and finish was greatly superior. Marked differences were also observed in growth, foliage, colour, and texture of the fruit. It now remains to be seen as to what steps will be necessary in the way of manuring, etc. to keep the trees in a healthy condition.

Hops. The wet and dull conditions during July and August were unfavourable to the growth of hops, but were ideal for the spread of disease. This was particularly the case with Downy Mildew. However, by spraying twice with Bordeaux Mixture, as recommended by Professor Salmon, of Wye College, our crop suffered little from this disease. Although the yields were somewhat below our average, some good bold samples were produced.

The hop gardens now cover 8 acres. About 6 acres are devoted to the testing of 300 of Professor Salmon's seedlings, together with certain commercial varieties for comparison. Half an acre is planted with the early hop L21 (Tolhurst x English male hop) and nearly two acres are under certain selections of Professor Salmon's earlier introductions. The garden of Tutshams has been grubbed with the exception of half an acre.

A total growth of $3\frac{1}{2}$ tons was produced compared with nearly 5 tons for the same acreage in 1930. Although there is no quantity of any one variety of hop to market, one or more pockets of individual varieties give some indication of their comparative value under present conditions. The prices obtained for the 1931 growth showed a considerable improvement over those for 1930, many varieties making almost double the price this season. Canterbury Golding and Bramling came first, making £8 10s. per cwt., whilst none of the new seedling varieties reached this figure. Two seedlings of a Manitoba Wild Hop (C9a. 411) fetched £8, and a large number made £7 and £7 10s. per cwt. Our commercial growth of Tutshams made £7 per cwt.

Nine pockets of the early seedling L21 (Tolhurst x English male) sold for £6 per cwt.

Fresh Plantings. No planting of bush or top fruit has been done during the past year. The only new area planted is five acres on Newgates Field previously down to a manurial trial of Pyne's Royal Raspberries. These were cleared in the autumn and the ground planted with a temporary crop of Royal Sovereign Strawberries, in order to even up the land for future experimental purposes. The five acres on Upper Grub occupied by winter oats has been ploughed and subsoiled, and is now planted with fruit tree stocks.

APPENDIX.

Routine Spraying Programme, 1931.

January	*Winter.* Tar Distillate 6%	Apples, Plums, Pears, Cherries, Black and Red Currants and Gooseberries.
	Spring and Summer.	
	Against Scab, Caterpillar and Red Spider.	
May 4th to 7th ..	(a) *Pre-blossom "Pink bud" stage.* Lime-sulphur .. 3⅓ galls. Water .. .. 96⅔ galls. Arsenate paste 4 lbs. Gelatine .. 1 lb.	*Apples*—all varieties. (8 ozs. Nicotine was added where Capsid was known to exist.)
June 5th to 8th ..	(b) *1st Post-blossom.* Lime-sulphur .. 1 gall. Water .. .. 99 galls. Arsenate paste 4 lbs. Gelatine .. 1 lb.	*Apples*, excluding the following sulphur-shy varieties: Lane's Prince Albert, Rival, Beauty of Bath, Belle de Boskoop, Stirling Castle and St. Cecilia.
July 2nd and 3rd ..	(c) *2nd Post-blossom.* Lime-sulphur .. 1 gall. Water .. .. 99 galls. Gelatine .. 1 lb.	*Apples*, as for 1st post-blossom.
May 20th to 28th ..	*Capsid Wash.* Nicotine .. 8 ozs. Soft Soap .. 8 lbs. Water .. .. 100 galls.	*Apples*, where necessary.
	Against Scab.	*Pears* (applied to one plantation where gooseberries undercrop).
April 22nd	*Pre-blossom.* Copper Sulphate 8 lbs. Lump Lime .. 8 lbs. Water .. 100 galls. Gelatine .. 1 lb.	
April 16th and 17th	Against Scab, Caterpillar and Red Spider. *Pre-blossom.* Lime-sulphur 3⅓ galls. Water .. 96⅔ galls. Arsenate paste 4 lbs. Gelatine .. 1 lb.	*Pears* (applied to two plantations).
April 10th	Against Big Bud Mite. *Pre-blossom.* Lime-sulphur 8 galls. Water .. 92 galls.	*Black Currants.*
June 12th and 13th	Against Beetle.	*Raspberries.*
June 29th	During blossoming (twice). Derris preparation .. 5 lbs. Water .. 100 galls.	

Section II

*GENERAL REVIEW OF RESEARCH WORK**

POMOLOGY

A. In Relation to Tree Fruits

(*a*) ROOTSTOCK INVESTIGATIONS.

1. Stocks for Apples.

Indications of rootstock effect upon the scion have now been recorded on 1,613 trees of Lane's Prince Albert for fourteen years; on Bramley's Seedling and Worcester Pearmain for thirteen years; on Cox's Orange Pippin and Stirling Castle for ten years, budded upon the stems of a considerable range of vegetatively raised rootstocks. It is obvious that the picture is as yet incomplete since none of the trees, even in the " very dwarf " group, appear as yet to be deteriorating. In the intermediate groups there are signs that trees on certain stocks such as Nos. VII and IV are reaching a maturity of cropping which is now reflecting itself in a slowing down of growth. Again, whilst on certain of the " very vigorous " stocks all varieties have shown little sign of cropping up to the present, on others, such as East Malling XVI, Crabs A and C, and Long Ashton OF5, the large framed trees are showing comparatively early fruiting. That the influence of vegetative rootstocks becomes more marked with the age of the tree seems certain, and this brings to the fore complementary problems of cultural and nutritional conditions which are now being studied.

The effect of the grassing down of some two hundred trees of Bramley's Seedling and Worcester Pearmain on various rootstocks has, after only two seasons, been very marked. Whilst the cropping and colour on the whole plot has been enhanced, the different response of the trees on different rootstocks is still quite obvious. Similarly, the response of the same varieties on different rootstocks to conditions of starvation and various manures is being followed up.

It would now seem fairly safe to pass a preliminary judgment upon the suitability of some of the East Malling " very vigorous " layered stocks for orchard purposes. Half-standard trees of Lord Derby, Newton Wonder and Allington Pippin, now some eight years old, all suggest that No. XVI, and Crabs A and C are of general promise. The former is in addition an easy stock to produce in the nursery. It appears to be synonymous with the German Ketziner's Ideal—whence it came to this country in 1914. No. XII is remarkable for producing very vigorous trees, but it has been much slower to show signs of cropping, whilst No. XIII does not seem equally suited to all scion varieties.

A wide range of varieties have now been established on the Jaune de Metz Paradise No. IX and in every case comparative dwarfingness and early fruiting have resulted. There is not infrequently a tendency for the scion variety when worked on this stock to establish itself on its own roots, and also to blow out at the point of union, even after a number of years, if left unstaked—suggestive facts for those engaged in the study of the theoretical side of stock influence.

A further contribution has been made to the theoretical aspect of these investigations. Sufficient data have now been collected from the three series of trees grafted

* The initials in brackets at the end of each brief report indicate authorship and are those of the member of staff primarily concerned.

both on to the stems and piece roots of different vegetatively raised stocks to make it possible to state that stock influence lies at least as much in the root as in the stem of vegetative stocks. A paper presenting the evidence has been published (E52).

A paper has been published showing how the use of trees on standardized root-stocks has contributed to the elimination of sources of error in field experiments (E45), for, it has now been shown that not only does a single variety grow and crop differently on different rootstocks, but even that it responds differently to the same manurial treatment and has a different potentiality for resistance to disease. (R.G.H.)

2. Stocks for Pears.

Whilst there is now evidence to prove that the different quince rootstocks have marked differential effects upon the scion varieties in the early years, recent observations on the changes in growth and foliage suggested that, despite the considerable care exercised in planting the unions above ground, a number of the trees had now become established on their own roots. An examination of the below ground portions confirmed this. It seems certain that this phenomenon is much more general than has been expected, and that it may shed a fresh light on the behaviour of trees supposed to be on quince roots. A new series of trees budded much higher on the stock stem, is in course of preparation.

All varieties worked on quince C have produced much more blossom than on quince A and B (Angers and Common), and in those cases, such as Conference, Fertility and Durondeau, where heavy crops have resulted, these are now becoming reflected in the smaller size of the trees.

The Dr. Jules Guyôt bush and half-standard trees on clonal races of "Free" (*P. communis*) stock are already exhibiting a range of growth and blossom performance. Although some thousands of layers of the principal selections from single plants have now been produced, the majority do not stand the transplanting as readily as apples or plums. Root cuttings (used on a large scale in the commercial production of Mussel plum stocks), are therefore being tried, whilst further selections are being made and tested. (R.G.H.)

3. Stocks for Plums.

Most of the rootstocks possessing any marked dwarfing effect upon plums (Common Plum, St. Julien de Toulouse and Brussels) have so far proved of very limited value, since they are incompatible to the majority of varieties, so that further selections from seedling races, and testing of the subsequent clones, are being made. For general purposes, a rootstock of the Pershore type, more ready rooting and with better anchorage, is the ideal being sought. Common Mussel is the nearest approach to an all-round stock for plums and peaches, but on some soils it is prone to leaf scorch and of course many consider its suckering habit a nuisance.

The Malling selection, Myrobolan B, continues to show the greatest promise as a very vigorous rootstock for all varieties so far tested. Its ease of propagation from wood cuttings and layers also recommends it. Its behaviour in the field even suggests some degree of resistance to diseases such as Silver Leaf (*Stereum Purpureum*) and Bacterial Die Back (*Pseudomonas mors-prunorum*). This latter trouble has necessitated a search for resistant stems and frameworks upon which such desirable yet highly susceptible varieties as Victoria might be "over-worked." (R.G.H.)

4. Stocks for Peaches.

A progress report (E44) mainly on the nursery aspect has been published. Various incompatibilities have been found in the young trees, especially amongst the frequently

used Damas and Julien rootstocks. The vigour of the tree can be controlled to some extent. In pot culture under glass the trees on Brompton produced outstandingly the heaviest crops.

The trained trees on various rootstocks should in the forthcoming year, bear their first full crop. Clonal races of "Common" Peach have been raised from layers and some Myrobolans (*P. cerasifera*) apparently compatible to Peaches have been introduced from U.S.A. and the Continent of Europe. (R.J.G.)

5. Stocks for Cherries.

(i) *Acid Cherry* (*P. cerasus*) *scions.*

The seven year old plantation of bush Morellos now shows a most striking contrast in vigour and habit of growth and behaviour between adjacent trees worked on vegetatively raised *P. avium*, *P. mahaleb* and *P. austera* rootstocks. A younger plantation is already showing considerable differences between the various selections of Mazzard (*P. avium*). Further selections of Mazzard rootstocks will have a preliminary trial with Morello scions.

The experience gained in carrying out the routine cultural, disease control, and marketing operations on these plots has been embodied in a report (E50).

(ii) *Sweet Cherry* (*P. avium*) *scions.*

The standard trees planted three years ago, worked on a collection of clonal Mazzard (*P. avium*) stocks are now giving indications of stock influence on vigour, but from the very nature of the material the results are bound to develop slowly.

Certain recently acquired vegetatively produced acid cherry stocks, the "Stockton Morello" from California and the so-called "Kentish" from Australia—reputedly used for dwarfing sweet cherry varieties—are being described and propagated as rapidly as possible for trial with sweet cherry scions in this country. (N.H.G.)

6. Propagation.

Much of the work under this head consists of the careful preparation of material for experimental plots, but interesting data from these carefully recorded experimental nurseries become available with reference to peculiarities in the early stages of the life of the plant.

The search for new rootstocks continues and these are being tested for ease of propagation and incompatibility in the nursery.

The experiments in the propagation of fruit tree rootstocks by means of hardwood cuttings and root cuttings are being continued, and findings, which may be of practical value, will be further tested on a commercial scale in the field.

Work has begun on the benefits or otherwise of "stem builders" and disease resistant frameworks for apple and plum trees. (R.J.G.)

(*b*) ANALYSIS OF ROOTSTOCK INFLUENCE, INCLUDING THE RECIPROCAL EFFECT OF SCION UPON ROOT.

Reference is made to the progress of this work under A1 and C1.

(*c*) ROOT DEVELOPMENT INVESTIGATIONS.

The excavation of the roots of a comprehensive series of mature trees on clonal and seedling roots under very varied conditions of soil, moisture and aeration conditions, has given some valuable information as to the parts played by these interrelated factors upon root development. Arrangements have been made with the Dominion of Canada

Experimental Farms for following up these preliminary deductions under conditions of artificial irrigation at Summerland, B.C.

The intensive observation of actual root growth upon the two contrasting types of root system (Nos. I and II) was elaborated this season. Eight young trees are being grown in observation boxes with glass sides, filled with different soils, and suspended below ground level in darkness. Frequent observations of growth were measured and recorded photographically and some valuable micro-photographic details obtained.

A thirteen year old root system of Lane's Prince Albert on No. I rootstock was kept under constant observation by means of an observation trench with glass windows —the whole being kept darkened. It is intended to extend these observations to other rootstocks in the forthcoming season.

The importance of soil temperature and moisture in such observations is obvious, and preliminary efforts have been made to record these. This has involved some work upon possible soil moisture recording apparatus, and it is ultimately hoped to regulate these factors in the observation cases. (R.G.H. for W.S.R.)

(*d*) INVESTIGATIONS IN BIENNIAL BEARING.

These have been initiated with apple trees and, in an attempt to analyse the causes, the removal of part or all of the fruit buds, at different stages of development, from either the whole or parts of trees already exhibiting the habit, is being carried out. Records from the rootstock, pruning, fruit thinning and manurial field trials are also being analysed from this point of view. (N.H.G. and A.C.P.)

(*e*) DOUBLE-WORKING OF FRUIT TREES.

Sufficient data has been collected over the past twelve years to show that certain combinations of " intermediate " and second scion give good or poor results as affecting the initial union and subsequent growth and fruiting. It is at least possible to warn growers and nurserymen that it is dangerous to top work any one variety upon any other without previous experience, and that supposed suitabilities from *a priori* reasoning have proved failures—as in the case of the use of Bramley's Seedling as an invigorating intermediate for Cox's Orange Pippin. Again, certain generally suitable intermediates for double-working pears on quince have been indicated. At present however, no general principle for right selection seems emerging from field trial methods and it will only be by an exhaustive series of combinations of intermediate and second scion that the desired information can be acquired. This can only be attempted gradually.

(N.H.G.)

(*f*) INVESTIGATIONS INTO THE NON-SETTING OF THE BLOSSOM OF CERTAIN VARIETIES OF PEARS.

The influence of rootstock and pruning methods upon the blossoming of pears has for some time been under investigation. These studies have emphasised the fact that whilst certain varieties may be made to produce blossom in the early years by these methods, fruit setting does not necessarily follow. A concerted attack on this problem from the point of view of cross pollination, stem-ringing, fruit bud thinning, nutrition, double-working, etc., is being made. (N.H.G., N.B.B. and H.M.T.)

(*g*) PRUNING.

1. Apples.

For the study of pruning along the original lines, the pruning plot has now reached the end of its usefulness and a review of its seventeen years performance is nearing

completion. The present state of some of the trees raises entirely new problems—their present pruning needs calling for a radical change of scheme. Investigations of renovation by dehorning, thinning, spur thinning and shortening—have already been initiated. On a number of young trees the question of the optimum time for leader pruning will be studied. (N.H.G.)

2. PEARS.

These investigations are being maintained and developed in the light of the addition to the programme, Section (*f*). (J.A.)

3. PLUMS.

The pruning and thinning of plum trees at different seasons of the year is closely bound up with the problems of Bacterial Die Back and Silver Leaf infections, from which point of view they are being developed. (J.A.)

4. CHERRIES.

A trial of the best methods of pruning developed bush Morellos has been initiated. (N.H.G.)

(*h*) FRUIT THINNING.

1. PLUMS.

Two reports have been issued on the very definite results of a single year's experiment on the thinning of Victoria plums (E46 and 48). The increase in size and quality of the fruit and the higher net return compensated for the actual lower aggregate yield of the thinned trees. The thinned trees had practically no broken branches, whilst the unthinned were severely damaged. The labour costs too were found to be favourable to thinning. These experiments will be continued when sufficiently heavy crops are available, and extended to certain other varieties of plum.

2. APPLES.

The experiment started in 1927 on young trees has been continued and extended. Certain effects on tree growth, etc., are already obvious and it is hoped to issue a progress report shortly. The results of thinning the fruit on thirteen year old trees of several varieties has so far been less decisive. (A.C.P.)

(*j*) MANURING OF FRUIT TREES.

1. APPLES.

The discovery that the same variety of apple on different rootstocks shows a significantly different response to the withholding and application of fertilizers has led to the development of manurial trials on older trees of known history, and further layout of specially designed field experiments in which the interaction of variety, rootstock, manures, cultural conditions, etc., will be closely observed in relation to fruit crop, quality, disease susceptibility, biennial bearing, etc., over a period of years. It is already evident that, under modern methods of standardization of material, plot layout and recognition of deficiency symptoms, indications of a differential response can be detected in quite young trees. (W.A.B.)

2. In view of the seriousness of the Bacterial Die Back of stone fruits, the nutritional aspect in relation to possible inducement of susceptibility is to be investigated in collaboration with the Pathology Section. A start has been made with Victoria plums in pot culture, and young stocks in the nursery prior to an extended study in the field. (F.H.B.)

(*k*) VARIETY COLLECTIONS AND TRIALS.

The observations made on the apple and pear collections over a number of years have been reviewed during the year. Most of those varieties which are worthy of retention for further trial, breeding purposes, or on account of particular peculiarities, are being worked on very dwarfing apple (IX) and quince (C) roots and transferred to the cordon " Library." (H.C.C.)

Considerable work has been done on the nomenclature of the very extensive collection of cherry varieties. (N.H.G.)

(*l*) FRUIT BREEDING.

1. Rootstocks.

The raising of new apple rootstocks combining immunity to attack by Woolly Aphis with the desirable characteristics of certain of the Malling series, undertaken in collaboration with the John Innes Horticultural Institution is progressing. Certain of these new seedlings of proved immunity have now been propagated in sufficient quantities to allow of their being worked with Lane's Prince Albert for an intensive nursery trial of their performance. Since approximately not more than five per cent. of these crosses produce immune seedlings a joint effort is being made to raise up to 1,000 per annum for testing.

Over nine hundred seedlings from crosses between the Malling selected rootstocks are being " stooled " this winter to test their potentialities for vegetative propagation. It is hoped from amongst these to find some improved rootstocks, combining the best qualities of some of the existing ones.

2. Scion Varieties and the Shortening of the " Juvenile " Period.

Further seedlings from crosses between apple varieties were raised during the past season with the object of obtaining a succession of new varieties of good quality and colour.

A large batch of seedlings has been worked on dwarfing and vigorous rootstocks to test further the effect of the rootstock in shortening the " juvenile " period of such seedlings. A preliminary experiment suggested that this possibility was worth further investigation. At the same time an adult tree is being top worked with young seedlings. Meanwhile material is being prepared for a larger and more definite trial.

The work of raising pear seedlings designed to produce new varieties of high quality and extended season is being continued. (H.M.T.)

(*m*) POMOLOGICAL ASPECTS OF SPRAYING.

This work is being developed by the Pathology Section (*q.v.*) in relation to the new field experiments detailed under (*j*)1.

(*n*) MARKETING PROBLEMS.

The influence of such factors as variety, stock, pruning, thinning, cultural and manurial conditions is being carefully watched in relation to market value over a series of years (see (*h*)1). (A.C.P.)

(*o*) THE KENT FRUIT SOILS SURVEY.

The pomological survey of the Lower Greensand has been concluded. Detailed records have been taken in 924 plantations on 147 farms, the total area surveyed being 4,225 acres. This comprises about one-quarter of the total acreage of fruit in the area

and is representative of the whole. Analysis of these records has given very useful information with regard to the distribution of kinds and varieties.

The farms surveyed in the third year were mainly on the Folkestone Sand east of Bearsted and on the Hythe Beds in the Otham-Langley-Loose district and east of Egerton.

Further correlative work has shown that on a number of the soil series a definite standard of growth of fruit trees and bushes can be expected. This may vary with kind and variety of fruit and be the same for a number of the soil series. The great importance of soil water conditions has become clear.

The necessity for consideration of a large number of factors before a certain standard of growth or fruit quality is attributed to soil conditions has been confirmed. In this connection the variation in percentage of blossom set and fruit colour resulting from differences of rootstock and manuring has been studied on apples of known history at East Malling. (W.A.B.)

(*b*) WALNUTS.

1. Propagation.

Vegetative races of representative varieties of *J. nigra, regia and californica,* etc., are being raised by layering and soft wood cuttings as a basis of rootstock investigations. Stools were opened up in November, 1930, and the layers were counted on each stool. Rooting on the layers and on old wood was noted, and the percentage of rooting on the layers was recorded. The layers were then cut off and planted.

Methods of grafting under glass, of grafting and patch-budding in the open nursery are being tried on seedling *J. nigra* stocks from a known parent. One hundred and thirty trees were raised under glass last year, bringing the total number of grafted trees raised since the work was commenced to 698. Only about twelve per cent. of the trees worked in the open nursery have so far been successful, but even this small percentage is sufficient to indicate the possibilities of outdoor propagation if the correct technique were found. Experiments will be continued in this direction this Spring.

2. Varieties.

Altogether sixty-four American, Continental, Eastern and English varieties of walnut have been obtained. It is proposed to grow these at two centres at least.

Twelve varieties have been definitely selected for rapid propagation and distribution and six sets of twelve trees each, including most of these selected varieties, are being distributed to different localities.

Last Spring records were taken of dates of leafing out of trees in nursery beds in order to find out which varieties are likely to be injured by frost in this climate.

The larger trees planted in the open and in the Orchard House were hand-pollinated last year. The resulting nuts (from the Orchard House) were collected and records of dimensions, quality, sealing, etc., were taken. Enquiries for grafted walnut trees have been received from Australia and South Africa. (J.B.H. and A.W.W.)

3. Observations on Established Seedling Trees.

In Winter, 1930, graftwood was collected from the five Competition trees which are being propagated, and from the tree at Leeds Castle which bears nuts in clusters.

In the Spring, 1931, information was obtained in writing on the question of pollination of the above trees. In every case it is now known whether the trees were self- or cross-pollinated in 1931.

In July, 1931, the crops from the tree at Leeds Castle and from another tree in Kent were obtained. These trees bear small soft-shelled nuts in large clusters. Samples from both trees were tested by two pickling firms with very satisfactory results.

The Competition trees were visited in August, 1931, and notes were taken on the probable crop, the disease present, the condition of the tree, etc.

4. Oil Content Determination Work.

The percentage of oil and moisture were determined in January, 1931, in samples of fresh nuts from the six mature seedling trees selected at the Walnut Competition in 1929. These results were compared with those obtained by Mr. Howard Spence in 1929. It was found that the oil content of these nuts, though still higher than the average, was slightly lower in every case than in 1929. This was to have been expected on account of the heavy rainfall in 1930, when the nuts were maturing.

5. Curing and Storage Trials.

Two samples of nuts were used :

(1) from one of the selected Competition trees, therefore of known high oil content,
(2) an average sample from a local tree.

After deshucking and washing, a portion of nuts from each sample was dried in the furnace room at 90° F., until no more moisture was lost. The fresh and dried nuts were then submitted to various fungicidal and bleaching treatments and stored in earthenware pots in salt, peat moss fibre, coconut fibre or sulphur at a temperature of 36° F. Five nuts were removed from each pot every month from November to April, inclusive, and examined for plumpness of kernel, appearance, disease, etc.

The best results were obtained from nuts which had been bleached in chloride of lime and then stored in coconut fibre or salt. Salt is unsatisfactory in that it is extremely deliquescent. Experiments are being continued this Winter to see if better results are obtained by dipping the nuts in a saturated salt solution before storing, so that the salt is present as a thin deposit on each nut instead of in a surrounding mass.

The kernels of high oil content remained considerably more plump than the " average " kernels. At the end of the season dried nuts were less plump and richer than fresh nuts, but did not appear to be less prone to attack by fungi as was expected in view of their lower moisture content.

6. Diseases.

See Pathology Section. (J.B.H.)

B. In Relation to the Small Fruits

(*a*) NOMENCLATURE, CLASSIFICATION AND VARIETY TRIALS.

Now that a centralized Variety Testing Scheme is supported by the Ministry of Agriculture, and that in the case of currants and raspberries, East Malling has established a satisfactory technique for crop comparison, this work will not be developed, except as a sub-station of the central testing station.

The cropping trial of the Malling clonal races or red currant, established three years ago, will be allowed to run its normal life, and with regard to black currants, sufficient figures should now have been collected on the plots, designed for triplication at Long Ashton and Wisley to permit of their summarization.

Papers describing the methods of identifying the chief worthless rogue varieties commonly found amongst and sold as Baldwin's black currant, have been published (Esf17 and 20).

Two papers summarizing the results of the raspberry cropping trials have been issued (Esf15, 16). In future, only a few specimen plants of some sixty of the most important varieties will be saved for reference purposes.

About a dozen of the more important varieties of blackberries and dewberries are being described and given a preliminary trial.

(*b*) PROPAGATION AND THE ESTABLISHMENT OF CLONAL RACES.

The logical outcome of the classification work has been the establishment of healthy clonal races of small fruits from selected type parent plants. In the case of red and black currants, and a number of raspberry varieties these re-selected clones are now available for distribution in considerable quantity, and they are believed to be "disease free." The amount of "reversion" in the clonal black currant plantations is negligible, and if all exterior sources of infection could be removed would probably disappear altogether. Similarly mosaic free races of certain raspberries are well on the way to establishment. Pure races of those varieties of gooseberry required for cultural and manurial trials are now available.

Clonal races of Royal Sovereign strawberry are being multiplied, and each individual runner, with its progeny kept under observation in certain cases. Any possible "degeneration" from methods of runner selection, as distinct from the intervention of disease, is being watched, whilst suitable material for an extension of cultural experiments is being built up. The best methods of raising and transplanting some of the more important varieties of Rubi are being sought on clonal material.

(*c*) PLANTING, TRAINING, PRUNING, ETC.

The strawberry "uniformity" trial, planned for a study of the variability of plants in the field, is yielding valuable information which will be utilized in the future layout of strawberry investigations. Papers have been published (Esf18 and 19) dealing with the effect of strain, time of planting and de-blossoming upon cropping, size of plant, and runner production, in a three year experiment, designed upon statistical principles. Selection of parent plants and multiplication of clones has considerably reduced the variation between the strains. Under East Malling conditions, early autumn planting has given the best results in cropping, vigour and runner production. De-blossoming increased both size of plant and runner production. These questions are receiving further attention.

Various methods of pruning red currants and gooseberries in conjunction with certain cultural and manurial treatments are under elaboration.

The training of loganberries is being studied in relation to cropping as well as disease factors. (J.A. and R.G.H.)

(*d*) MANURING OF RASPBERRIES.

The two experiments initiated in the Autumn of 1927 in the manuring of Pyne's Royal and Lloyd George raspberry have now yielded definite results and a report has been issued. In addition to their pomological value, these trials, which were the first to be laid down using modern methods of plot arrangement, have yielded valuable information concerning the planning and conduct of such experiments. The necessity for uniform material, free from disease was clearly shown and the Lloyd George trial

provided an excellent example of the possible influence of soil variations, which was in this case much greater than that of the manurial treatments.

Nevertheless differences due to manuring were quite clear, the need for a proper balance between potash and nitrogen being the most important fact demonstrated, with *both these very different varieties*. Nitrogen alone, though it may produce more cane, has never produced a greater crop and has proved actually depressing in both cases.

(T.N.H.)

(*e*) FRUIT BREEDING. BLACK AND RED CURRANTS.

Approximately 1,000 seedlings, the result of crosses between the main varieties of black currants, are being examined in detail, in an attempt to elucidate the inheritance of numerous characters. Certain seedlings from a further plot of 1,000 bushes, now four years old, have given promising indications of heavy cropping. After another season, the most outstanding will be selected for further trial. Two of the original seedling crosses, Wellington's Triple and Double X, have now stood some twelve seasons' test. They combine certain very desirable qualities and several growers who have tried them on a commercial scale are anxious to obtain more.

Through the kindness of the Director of the John Innes Horticultural Institution, it has been possible to arrange for a preliminary experiment on the artificial production of mutations in black currants by subjecting seeds, flowers and pollen to X-radiation. The treatments are to be carried out at Merton and the resultant seedlings raised at East Malling. It is possible that such mutations may in certain cases prove of economic value.

Crosses between black currant varieties and nearly related Ribes species are being raised in the hope that such hybrids will contain new and desirable combinations of characters. The Station's collection of such species is being augmented as opportunity offers. A number of seedlings from crosses and selfs between red currant varieties are now under observation. (H.M.T.)

RASPBERRIES.

After a first selection, some forty seedlings promising to show some improvement upon the commercial variety Lloyd George have been reserved and propagated for further trial. It is intended during the next two years, to reduce this number to three or four and then to offer these for final trial under the Ministry's central testing scheme.

Further selfs and crosses are being made. (N.H.G.)

STATISTICS AND RECORDS

The summarization and analysis during the past three years of the considerable mass of accumulated data (over a thirteen year period) have borne fruit during the past year, whilst the trial of methods of plot layout, comparatively new to horticulture, is now sufficiently advanced to make it possible to lay down certain general recommendations for the conduct of field experiments with fruit plants.

PLOT LAYOUT.

The older methods of plot layout, where an indefinite number of trees were scattered about the ground with little regard to the subsequent interpretation of their performance, have been superseded by modern methods of layout such as those now common in agriculture (e.g. the method of randomized blocks) adapted to the peculiar difficulties met with in permanent crops.

Enough is now known of the variation in such diverse crops as strawberries, raspberries, currants, apples and hops, to enable trials to be laid down with an adequate, and at the same time economical, number of repetitions to prove the kind of differences which are to be expected.

It has been possible to review several of these new trials during the year, especially those with small fruits. These trials have shown very clearly the value of the new methods, not only in their accuracy, but in the more complete information as to the interaction of two or more treatments or the differential responses of different varieties to given treatments.

The knowledge gained in the planning and conduct of two large scale manurial trials of raspberries, using modern methods of plot arrangement, has been described in a report recently issued (E51).

TECHNIQUE OF RECORDING.

Once planted, the recording of the tree's life history has been made a subject for especial study. The various methods of measuring the growth and cropping in trees have been reviewed, and it is now possible to make recommendations as to the necessary measurements to be taken. For example, the relationship between the girth increments, annual shoot growth, and other measurements of tree vigour has been examined with a view to discovering which, if any, of these can best determine the vigour at any particular time. The fact that none of these alone can adequately express this has brought a new train of problems ; such as that of measuring annual shoot growth on older trees, where the enormous growth renders the measurement of any great number of trees a physical impossibility.

In this connection a method of sampling the growth of spur pruned trees has been developed, which depends to a large extent on the weight of those prunings, and is now in use on several plots.

Other methods of sampling have been worked out, such as that in use for measuring the ratio of blossom production to fruit set.

These findings have been set forth in several reports published during the year. A paper published in the proceedings of the Imperial Horticultural Conference was further expanded into a memorandum (E47) dealing in great detail with the matters discussed above, including a section on experiments with tropical fruits, and giving several examples and the methods of working out the results in detail. It further included a bibliography of over 100 papers on the subject.

In the Summer two short papers dealing with technical methods and the peculiar difficulties of extension trials were prepared and read at conferences. The former has already been published (E54). (T.N.H.)

PHYSIOLOGY

Vegetative Propagation.

Investigations on the conditions favouring rooting in hardwood cuttings have been continued in collaboration with the Propagation Department. Improved rooting in plum cuttings has again been secured by placing a layer of sphagnum moss beneath the sand of the cutting bed. A layer of spent hops was not so effective as the layer of sphagnum. No marked improvement in rooting was obtained by shading the cutting bed with muslin in late spring and early summer, but the combined effect of shading and of a layer of spent hops is being tried this season. The investigation of the effect of the time of planting upon rooting is being extended to include the planting of cuttings early in September. A number of cuttings were made last autumn from shoots whose bark had been previously ringed, notched or split at the point where the basal cut was subsequently made ; these cuttings, however, are being left in position for another year. The effect of treating the base of the cuttings before planting, with dormancy breaking chemicals, such as ethylene chlorohydrin and thiourea, has been tried ; these cuttings, too, are being left in the cutting bed for another season.

Leaf Relations in Apple Trees.

Investigations to determine to what extent the influence of rootstock, pruning and cultural treatment upon vigour, precocity and other characteristics of a tree, become effective through their influence upon leaf relations, have been continued. Since practically the whole of the supply of the very important element carbon, which makes up the greater part of the dry matter in a tree, is obtained through the agency of the leaves, any factor that alters the amount of leaf surface, the time of year at which it is developed or the efficiency of the individual leaves, may be expected to influence the behaviour of the tree, by altering its carbon relations.

Before a thorough investigation of this problem could be attempted, a quick and accurate method for determining the area of the leaves, without detaching them from the tree, had to be elaborated. This has now been done and the method has been applied this autumn to the measurement of every leaf on two nine year old Laxton Superb apple trees, one on Malling No. IX, the other on Malling No. V. There were about 10,000 leaves on the one and some 20,000 leaves on the other. The main objects of this investigation were to test the technique on large trees, to get some indication of the magnitude of the differences in leaf relations to be expected as a result of stock influence and to explore the possibility of applying some form of the " sampling " method to the estimation of the leaf relations of a tree. The data have supplied useful information on all these points and are being prepared for publication. The work is now sufficiently far advanced to allow the fuller investigation to be begun next year.

Work on another aspect of the same problem has been begun this autumn ; quantitative estimations are being made of the carbohydrates in the leaves of an apple variety worked respectively on a dwarfing and a very vigorous stock, to determine whether the efficiency of the leaves, as carbon fixing organs, is influenced by the rootstock upon which it has been worked.

GROWTH.

Seasonal Course of Root and Shoot Development in Apple Stocks.

The investigation into the seasonal course of growth in an apple stock and into its distribution between the various organs—roots, stems and leaves—has been continued and a progress report (1) has been published on the growth during the Maiden year of trees planted in the springs of 1929 and 1930. The trees were weighed before planting and were lifted in random samples of about fifty at intervals of about a month. Their rates of growth at different seasons were determined from the differences between the weights of successive samples. The increase in weight of a tree during its Maiden year was found to be more or less proportional to its weight at planting. Thus trees that were six times as heavy as others at the time of planting were still six times as heavy at the end of the growing season ; in each case the weight (including leaves) at the end of the season was about double that at the time of planting. This emphasizes the desirability for using first grade material for " working " ; low grade material will not even up with high grade by a faster rate of growth during its Maiden year. The curve of increase in leaf weight was of the usual S form in both years and that for increase in root weight during the growing season was of the same form in 1930. In 1929 there was a depression in the rate of root growth in August which corresponded with a spell of very dry weather. The whole tree decreased in weight during the winter months ; this was especially marked in the case of the roots in the winter of 1929-30, due, perhaps, to excessive dying off of young roots owing to the very wet conditions incident that winter. The course of growth during the second year after planting has been investigated during the current year and will be followed until April, 1932.

EFFECT OF SCION ON ROOT.

In the course of work previously reported which showed that different rootstocks retain their varietal characters irrespective of the influence of scion variety, indications were obtained that the percentage of fibre was dependent in some degree upon the size of the root system. In collaboration with the Pomological Section, a batch of nearly 400 two year old trees of Grenadier exhibiting a wide range of size of root system has been lifted and analysed to investigate this point more fully and the records are now being examined.

Material has been prepared this season for seasonal observations on the leaf, stem and root development of the two apple varieties, Grenadier and Beauty of Bath, in order to investigate the causes for the marked difference in the amount of root produced by stocks worked respectively with these two varieties.

BIOCHEMISTRY

Stock Influence.

The general lines of attack have been outlined in two progress reports (K3 and 4). Work last year on this problem was confined almost entirely to evolving methods to solve the very difficult analytical problems which have arisen.

Ash Analysis.

Work on Heyrovsky's polarographic method for estimating minute amounts of metallic elements consisted of a few attempts to replace the dropping mercury cathode which had been found troublesome. Recently published work of Heyrovsky's co-workers having demonstrated the necessity for greater complication of the polarographic method than at first seemed necessary, the spectrographic method then appeared the more promising one to develop first.

Spectrographic apparatus purchased with a grant from the Government Grant Committee of the Royal Society has been set up. The large number (over twenty) of elements present in the ash and the limited amount of ash available necessitate a highly efficient sparking apparatus. A number of pieces of such apparatus have been built up and tested. The one now being tested appears likely to be satisfactory.

Functions of the Ash Constituents.

Observation of the trees injected last year (K4) has revealed the quantities of the various substances which may be injected with safety. There was a suggestion that an injection of sodium thiosulphate in the autumn suppressed the primary mildew infection in the following summer but had no effect on scab. Material was prepared for determining the function served by molybdenum in Type IX rootstock.

Resistance of Different Rootstocks to Insect Attack.

(Jointly with Entomological Section.)

Causes of Resistance to Woolly Aphis.

In the first progress report (K5), in which the methods of attack were outlined, two artificial culture methods were described. The one in which the woolly aphides have to puncture a membrane to reach the food has been improved and has given better results than the agar method.

The average length of life of the adult insects was not appreciably affected by taking them from their natural host and placing them on artificial media, but the average length of life of the young born after the mothers were placed on the artificial media was short, nine days being the best so far obtained. The figures suggest that in the preparation of most of the media, both from susceptible and immune bark, some substance toxic to the nymphs had been produced or liberated. The properties of this substance correspond with those of anthocyanins which have been recognized in apple bark (see below). In seven out of eight comparisons between media differing only in the one being prepared from immune, and the other from susceptible, bark the susceptible bark medium gave the longer nymphal life. In the one comparison made between three media made from immune bark, susceptible bark and a mixture of the two, the nymphal life period for the last was about equal to that from the susceptible bark. These results suggest that the difference between immune and susceptible trees was extracted unchanged by

the methods employed in making up the media and that the differentiating substance is a food, necessary to the insect, which is lacking in the immune. This statement rests on too few facts to be looked on as more than a basis for further work. In so far as it is confirmed it will be a justification for a detailed search for the food substance by combined chemical and biological methods.

Chemical Examination of Apple Bark.

This work arose out of the need, for the woolly aphis immunity investigation, of determining the best method of extracting the constituents of apple bark (i.e. all tissues outside the cambium) in as near the condition in which they exist in the living tissues as possible, it having been found that at least one compound, occurring in the living bark as a bright red solution, was changed in the extraction into a brown insoluble substance.

A machine consisting of a shielded tempered steel wire wheel rotating at 2,800 r.p.m. has been devised to reduce bark to a fine state of division and shoot it into a solvent in one operation.

From the bark of Allington Pippin shoots with this machine, using alcohol as solvent, a solution was obtained from which fractional precipitation with lead salts isolated a red and a yellow substance with green and yellow lead salts respectively. The substances appear to be anthocyanins.

The distinctive red and yellow colours of the shoot barks of certain apple rootstocks are due to the presence of these substances and the colour of the lead precipitate has been found to be a fairly constant characteristic of apple, rose and cherry stocks. Similar precipitates from apple and rose roots varied according to the variety from lemon yellow to reddish brown. Chemical methods of identification based on the above facts have been worked on.

Some evidence has been obtained that varieties of rootstock differ in respect to a number of crystalline constituents which have not yet been identified, but an examination of which may well be of interest in connection with varietal differences of susceptibility to disease, etc., as well as in the study of varietal differences in general and of the rootstock effect. This work will proceed as opportunities occur. (W.A.R.)

PLANT PATHOLOGY, MYCOLOGY AND BACTERIOLOGY

1. Crown Gall.

The Relative Susceptibility of Apple Stocks to Crown Gall.

A progress report detailing the preliminary experiment carried out in 1929 to determine by artificial inoculation under uniform and controlled conditions the relative susceptibility of apple stocks to Crown Gall was published in 1931 (C60). In this experiment stock No. VII was markedly more susceptible than No. I both with regard to the relative numbers of successful inoculations and to the size of the resultant galls. On the basis of these results an extended series of experiments was carried out in 1930 and 1931 including a larger range of Malling stocks and consisting of (1) a pot inoculation test on similar lines to the 1929 experiment, and (2) parallel field experiments in which the same series of stocks was subjected to the conditions of natural soil infection. The results of these experiments which confirm those of the initial experiment in 1929 with regard to stocks Nos. I and VII and have provided information on the relative susceptibility of the other stocks included in the tests, are being prepared for publication.

(R.V.H.)

2. Brown Rot Diseases.

Three diseases caused by the Brown Rot Fungi have been under investigation.

(1) The common fruit rotting fungus *Sclerotinia fructigena* has been found to produce Brown Rot cankers on a number of varieties of apples. The fungus first infects the fruit and then extends from the fruit into the spurs and branches to cause cankers. It is important that such cankers should be noted and carefully cut out for if they are left the fungus spends the winter in them and reappears at the surface the following year to cause further infection (C47).

(2) Observations on Blossom Wilt of Morello cherries made in May, 1931, showed that in that year there were two waves of infection, one occurring before the flowers opened and the other during the blossoming period. In both cases the twigs were invaded from the infected flowers and killed back several inches. It is recommended therefore that all dead twigs should be cut out as soon as wilting is obvious to eliminate sources of infection and that the bushes should be sprayed with Bordeaux mixture soon after the buds burst in order to protect the unopened flowers (C65).

(3) A Blossom Wilt of Fertility pear trees have been found to be caused by *Sclerotinia cinerea* forma *pruni*, the fungus which also causes blossom wilt and fruit rot in plums and cherries (C53). (H.W.)

3. Bacterial Diseases of Fruit Trees.

It has been found that certain diseases, which result in great losses in plantations of plums and cherries in this country, are caused by bacteria. Organisms associated with these diseases have been isolated and are being compared in reference to their cultural characters and infective properties.

A wilting of young green shoots on Victoria plum trees has been found to be caused by a bacterium which has been isolated from naturally infected shoots and when inoculated into healthy shoots has reproduced the disease. Cultural tests indicate that the organism

is one that has not previously been described and it has been given the name *Pseudomonas prunicola* (C54).

A more serious disease of plum trees is Bacterial Canker, a form of " Dieback." Isolation and inoculation experiments have shown that this is caused by another organism, which, however, is closely related to *Ps. prunicola*. The symptoms accompanying Bacterial Canker have been recorded and the results written up and published (C69). The behaviour of the causal organism in pure culture and its mode of infection are being studied. The relation between the stem cankers and the infection of the foliage (Bacterial Leaf Spot) is being investigated with a view to discovering at what period of the year control measures are most likely to be effective. It has been found that the organism spends the summer on the leaves (Leaf Spot stage), and the winter in the stems and branches (Canker stage). Control measures therefore are being directed towards controlling the leaf spot stage during the growing period, and protecting the stems against infection in the autumn.

Observations made on the relative susceptibility of varieties of plums to Bacterial Cankers have shown that certain varieties rarely become infected and such varieties may therefore serve to provide stems or " frameworks " on which to " over-work " the more susceptible but more valuable varieties. Trees are being raised for trials along these lines. (H.W.)

4. Raspberry Diseases.

(*a*) *Cane Spot* (*Plectodiscella veneta*).

A paper describing work on this disease carried out from 1924 till the close of the 1929 season was written and published in 1931 (C64). In this paper the symptoms of the disease as they occur in Great Britain are described and data on relative varietal susceptibility collected over the period are summarized. The isolation and identification of the pathogenic fungus and inoculation experiments to establish its pathogenicity are briefly described and salient points in its seasonal cycle are given. Experiments are described which show that the disease on highly susceptible varieties may be controlled (i) by a modification of cultural methods and (ii) by spraying with Bordeaux mixture or with lime-sulphur. With the limited schedules used the former spray gave the most reliable results. Finally the severity of the attack of the disease is shown to vary greatly from season to season. The causes of this variation are discussed and a routine schedule of control measures is suggested.

(*b*) *Cane Blight* (*Leptosphaeria Coniothyrium*).

Observation on the symptoms of this disease and the seasonal cycle of the causal fungus have been continued. In addition to the varieties *Bath's Perfection* and *Reader's Perfection* mentioned in the 1930 report, serious attacks at East Malling on the varieties *Pyne's Royal* and *Goliath* were noted in 1931. Preliminary spraying trials carried out in 1930 gave negative results. There was evidence, however, that control can be obtained by cultural methods and a further experiment to test this was commenced on a grower's plantation in the 1931 season.

(*c*) *Raspberry Mosaic.*

The results of the past twelve years' research on this disease indicate that its incidence has a very serious bearing on the future of raspberry cultivation in this country and suggest at the same time the lines upon which its control may be achieved.

This research has been conducted from the two following points of view :

(i) A study and analysis of the leaf symptoms of disease, and of the correlated effect of infection on the subsequent history of the plant have been made with special

reference to the very striking differences in varietal susceptibility noted. This aspect of the work has been carried out (a) by systematic field surveys and observation carried out during the whole period and (b) by a series of controlled transmission experiments using grafting methods.

(ii) The rapidity and mode of spread of the disease on susceptible commercial varieties under normal field conditions has been studied and attempts made to check this spread by roguing methods.

On the basis of the results obtained along the above lines of work, a scheme for the control of the disease by raising mosaic-free cane of susceptible varieties on specially designed propagating plots was formulated, and experiments to test it started in 1928. The first two years' results of these experiments were sufficiently satisfactory to justify the laying down of similar plots in 1930 on farms of certain growers and Farm Institutes in Kent and Sussex in order to test the scheme under varying conditions. Detailed reports embodying the results of the work outlined above are in course of preparation for publication. (R.V.H.)

5. Loganberry Cane Spot (*Plectodiscella veneta*).

A preliminary spraying trial for the control of this serious disease of loganberries was carried out in 1931 at the Research Station. The treatments consisted of single applications of lime-sulphur at two strengths at the " delayed dormant " stage.

Although the complete results of this trial will not be available till 1932 it is clear by inspection that the control afforded by this treatment is not adequate. Observations made during 1931 strongly suggest that the serious attacks of the disease are due in part to the method of training now in common vogue. On the basis of these observations an experiment has been planned to determine the degree of control obtainable by combining a simple spraying schedule with various training methods. (R.V.H.)

6. Diseases of Cultivated Blackberries.

(a) " Blue Blotch " disease (*Septocyta ramealis*). A serious attack of this disease on a commercial plantation of blackberries was investigated. Preliminary experiments show that a degree of control can be obtained by modified training methods and by spraying.

(b) " Reversion." A preliminary investigation was made of an increasingly prevalent disease of the *Himalaya Giant* and the *Cut-leaved* varieties of blackberry which causes the canes and flowers to develop abnormally and results in complete sterility and ultimately in the death of the infected stool. The symptoms strongly suggest that the disease may be caused by a virus and material was collected during 1931 with the object of carrying out transmission experiments. The possible relation of a species of mite constantly associated with " reverted " plants, to the disease is being investigated by the Entomology Section (see report of Entomology Section). (R.V.H.)

7. " Strawberry Yellows."

The study of a serious deterioration disease of strawberries showing symptoms similar to those described by Plakidas in America was commenced in 1931.

In order to investigate the possible virus nature of this disease independently of the artificial infestation of plants with suspected insect vectors, experiments were carried out to determine, in the first instance, the possibility of grafting one plant on to another. An account of these experiments, which gave positive results, has been published (C71).

It is proposed to continue these experiments in 1932 from the point of view of virus transmission adopting throughout the method of grafting found to be the most satisfactory in the previous year's experiments.

The possible relation of the Strawberry Tarsonemid Mite, constantly associated with diseased plants, to the disease is also under investigation in collaboration with the Entomology Section (see report of Entomology Section). (R.V.H.)

8. Hop Wilt (*Verticillium albo-atrum*).

A further series of detailed records on the incidence and seasonal variation of this disease on the affected gardens at Penhurst and Matfield (Kent) was made in 1931. These records and those taken in previous seasons show that whereas the pathogenic organism is generally distributed throughout both the affected areas, the degree of damage due to this infection is closely correlated (i) with seasonal weather conditions and (ii) with local soil conditions. A joint examination of the soil of the affected gardens with the Kent Soil Survey has been arranged. (R.V.H.)

9. "Fruit-Russeting" and "Branch-Blister" Disease.

Cultural work has been continued in an endeavour to identify various strains of fungi associated with these symptoms. The supposed causal organism is tentatively referred to the form genus *Coniothecium* (C57), but diagnostic results are as yet inconclusive, as were those from numerous inoculations made in the spring with various strains of fungi in pure culture, in an attempt to show whether they are responsible for the symptoms shown by fruits and branches.

An investigation to test a possible relationship between vigour of tree and severity of fruit-russeting (distinct from spray-injury) indicated that the intermediate rootstock in some "double-worked" Cox's Orange Pippin trees showed no marked influence in this direction in 1931, when Bramley's Seedling and Stirling Castle were the intermediate stems concerned.

The results of spraying and dusting were inconclusive as regards fruit-russeting in this particular season. (M.H.M.)

10. Fungicide Trials.

Apple Scab and Apple Mildew.

The results of a replanned spraying and dusting experiment on some twelve year old Cox's Orange Pippin trees confirmed those obtained in a previous experiment (C52), in that three applications of lime-sulphur ("pink-bud," petal-fall, and three weeks afterwards) gave the most satisfactory control of these diseases. The single season's tests of post-blossom sulphur dusting gave promising results.

Certain data collected incidentally to those on Apple Scab on Cox's Orange Pippin showed that in 1931, as in 1930, the efficiency of a combined insecticide and fungicide against Apple Sawfly was greater than that of the same insecticide alone. (M.H.M.)

Pear Scab.

An experiment designed to test the efficacy of Bordeaux mixture, of lime-sulphur and of colloidal sulphur for the control of this disease was carried out on Fertility pear trees. Scab-grading of the fruits (both thinnings, and those picked when matured), showed that there was little difference in efficiency between Bordeaux mixture and lime-sulphur at the strengths used, both giving very satisfactory control, and that colloidal sulphur was only half as efficient. Some rootstock influence on scab-susceptibility was indicated. (M.H.M.)

11. Factors Affecting Susceptibility to Apple Scab and Mildew.

Manuring, and grassing-down and rootstock were all shown, in 1931, to have exerted an influence on the degree of susceptibility to apple scab infection on Worcester Pearmain and Bramley's Seedling. Evidence was also forthcoming that these influences were not exerted independently of each other or of the weather conditions. With Cox's Orange Pippin, previous indications of the influence exerted by the rootstock on scab- and mildew-susceptibility (C52) were confirmed. (M.H.M.)

12. Diseases of Walnuts.

Walnut Bacterial Blight.

After spraying an infected plant showing the marginal leaf spot, with water from a fine nozzle for several hours on five successive days, typical leaf spots were produced on a clean seedling Walnut placed below the infected plant. This suggests that the marginal spot precedes the typical infection, and that under natural conditions the bacteria are most probably washed from leaf to leaf during rain.

The disease appeared last spring on trees from which all bacterial lesions had been removed. Frequently all leaves from a single bud were attacked, thus suggesting that the organism may over-winter in the bud. To prevent spread of blight the importance of keeping a tree uninjured is emphasized.

The disease has now been found on five established walnut trees in England.

A Disease Following Grafting.

This year many trees grafted in the spring failed to form a union. Numerous dark, powdery spores were seen at the cut surfaces between stock and scion. In culture smaller, hyaline, rod-shaped conidia also developed endogenously. In preliminary experiments the fungus grew well in all inoculated plants while the controls remained healthy. The parasite has been identified as *Chalaropsis thielavioides*, a fungus not previously recorded for Britain.

Fungi Found on Walnuts in Store.

Fungi found on shells were : *Penicillium* sp., *Botrytis cinerea, Cladosporium* sp., *Mucor* sp., *Rhizopus nigricans, Pachybasium* sp., *Fusarium* sp., *Coniothecium* sp., *Alternaria* sp., *Pestalozzia Hartigii, Stysanus Stemonites*. Fungi found on the kernels were : *Penicillium* sp., *Botrytis cinerea, Mucor* sp., *Rhizopus nigricans* (C62). (J.B.H.)

ENTOMOLOGY

The Control of the Fruit Tree Red Spider.

A field spraying trial was carried out during the winter of 1930-1931 to test the value of a well-known petroleum oil against the eggs of the Fruit Tree Red Spider. The experiment was carried out on some badly infested plum trees growing at the Research Station, and the spray was applied at a strength of 10 per cent. in January.

Records obtained later in the season showed that the eggs of this mite were not killed by the petroleum spray, the hatch being similar on sprayed and untreated trees. This result confirmed observations made in growers' plantations in this and previous years. Further washes are being tested. (A.M.M.)

The Resistance of Different Rootstocks to Woolly Aphis Attacks.

Still further modifications of the methods used for testing apple stocks and seedlings for their resistance to Woolly Aphis have been made during the year, and details of this work have been published (D67). It has been found that quite young seedlings, with not more than two inches of growth, and contained in "Tom Thumb" pots can be tested satisfactorily under glasshouse conditions. This saves a great deal of valuable space in the greenhouse, and allows more accommodation for testing a larger number of seedlings in any one year. Of 118 seedlings raised by Mr. M. B. Crane, of the John Innes Horticultural Institution, Merton, and tested at East Malling, three were found to be immune, while five were found to be very resistant to aphis attack. The remainder proved to be susceptible ; many of them being killed as the direct result of aphis attack.

Two hundred and eighty-eight Spy crosses, raised by the Plant Breeding Section at East Malling were also tested. Of this total, ten seedlings were found to be very resistant and will be retained for further tests next year. The remainder were susceptible to aphis attack, the degree of susceptibility not being very varied.

Causes of Immunity.

Woolly Aphides have now been successfully kept alive on artificial media for periods of up to twenty-six days, and details of this investigation have been published (K5). The results suggest that the rate of reproduction of Woolly Aphides was more depressed by Northern Spy (immune) than by Allington Pippin (susceptible) extract (see also Biochemistry).

Woolly Aphis Parasite.

Renewed efforts to establish the Woolly Aphis Parasite have been made in the Maidstone district of Kent. The parasites were introduced into a badly infested orchard, but they were not observed to effect any appreciable control upon the Woolly Aphis. The parasites were still active at the end of September, but it remains to be seen whether they will survive the winter or not.* This work has been carried out in collaboration with the Plant Pathological Laboratory, Harpenden. (A.M.M.)

Apple Fruit Sawfly Investigations.

Some new observations on the life-cycle of this insect have been noted in 1931. The adults have been observed emerging from the soil during the flowering period. The

* Parasites still alive at the end of April, 1932.—A.M.M.

adults have also been observed depositing their eggs in the open flowers—and not just below the calyx, which is the normal position for egg laying.

The field spraying trials this season gave negative results, since the trees selected for the trials were not attacked by the Apple Fruit Sawfly to any marked extent.

The field trials with nicotine dusts also gave negative results. (A.M.M.)

Black Currant Gall Mite Control.

The field spraying trial was continued with the object of ascertaining whether a better, non-scorching spray, other than lime-sulphur, could be used as a post-blossom spray, on sulphur susceptible varieties of black currants.

The sprays tested were colloidal sulphur, a two solution pyrethrum spray, a petroleum emulsion and lime-sulphur plus aluminium sulphate. The results obtained demonstrate that none of these sprays was superior to a pre-blossom lime-sulphur application. In fact all the post-blossom sprays caused considerable fruit and leaf injury.

Although the pre-blossom lime-sulphur spray may cause considerable leaf scorch on some varieties of the Goliath group, the crop records showed that the bushes which received the lime-sulphur treatment have as many fruits as the untreated bushes. (A.M.M.)

Systematic Study of Gall Mites.

The systematic study of the species of Gall Mites which occur on plums are being worked out. In addition, the species of Gall Mites which occur on wild and cultivated blackberries are being studied. One species, *Eriophyes essigi* Hassan has been found in this country for the first time. This species is of definite economic importance in the U.S.A. where it was first discovered. (A.M.M.)

The Strawberry Tarsonemid Mite.

Recent investigations confirm the opinion that the Strawberry Tarsonemid Mite (*T. fragariae* Zimm.) may cause serious damage to some varieties of strawberries growing under natural conditions. Three reports have been issued (D65, 70 and 72).

Plants infested with this mite exhibit typical symptoms of mite attack, which are characterized by the malformed and crinkled leaves, the browning of young leaflets, and by the marked deterioration of the vigour of the plants. The leaves also become very brittle as the result of mite infection.

It has been ascertained that the intensity of mite attack may vary from season to season according to the climatic conditions prevailing. It has also been found that the runners become " naturally infested " from the parent plant, this infection taking place as soon as the runners commence to grow, and often before they are established on their own roots. Thus the necessity of selecting runners from healthy parent plants is imperative.

Identification.

Specimens have been received from different parts of the British Isles, America, Canada, and Holland. The British and Continental material proved to be identical (*T. fragariae* Zimm.) while the American and Canadian examples are found to be a distinct species, namely *T. pallidus* Banks.

Life-Cycle and Habits.

More details of the life-cycle have been obtained, and experiments are in progress to find out whether the strawberry mite has an alternative host plant in this country ; at present none has been discovered. In America *T. pallidus* Bks. attacks begonias, cyclamen and other plants, in addition to the strawberry.

Control Measures.

Preliminary control measures have been started under laboratory and field conditions. Tests have been made with lime-sulphur preparations, petroleum oils and pyrethrum sprays. In addition the treatment of plants by means of fumigation or by dipping them in hot water before planting is being investigated. At present the lime-sulphur preparations have been found the more effective in controlling the mite, and the practice of dipping runners in a 3 per cent. solution of lime-sulphur is to be recommended for commercial growers. (A.M.M.)

" Strawberry Yellows."

Investigations are in progress in collaboration with the Mycological Section, to determine whether the mite (*T. fragariae* Zimm.) is associated in any way with the strawberry disease described as " Strawberry Yellows." It has been found that the symptoms of the two diseases are quite distinct, but the association of this mite with plants exhibiting symptoms of "Strawberry Yellows" suggests that the mite may be a possible vector of the disease (see also report of the Mycological Section). (A.M.M.)

The Blackberry Mites.

Observations on the life-cycle of the Blackberry Mite (*Eriophyes essigi* Hassan) have been made during the summer. It attacks the cultivated blackberry, the cut-leaved blackberry, the Himalaya berry, the loganberry and also wild blackberries.

As soon as the fruits commence to develop they are attacked by this mite, and the result is a premature ripening of the fruits. This disease has been noted in America, and is described by the name of " Redberry " disease. The mite has been reported from several localities in Kent during the present year, and may prove to be of definite economic importance. A detailed description of the mites and notes on the life history have been published (D74).

The Mycology Section are carrying out experiments to determine whether a disease provisionally called " reversion " is caused by a transmissible virus. The constant association of *Eriophyid* mites with plants showing symptoms of " reversion " has been noted, and experiments will be carried out in collaboration with the Mycological Section to investigate the possible relation between the mites and the disease. (A.M.M.)

The Apple Blossom Weevil.

Investigations are in progress with the object of obtaining a new type of corrugated cardboard band which will withstand our climatic conditions, and will not be attacked and destroyed by field mice, birds, etc.

Some types of coloured bands tested during the year proved most satisfactory, but further tests will have to be made before they can be recommended on a field scale. In addition, a number of bands have been treated chemically, with the object of finding out whether this treatment will render the bands distasteful to birds and field mice, but at the same time will continue to attract the Apple Blossom Weevils. The preliminary trial gave very encouraging results. (A.M.M.)

Raspberry and Loganberry Beetle.

Observations made in the past season have thrown further light on the larval habits and may prove to have an important bearing on economic methods of control. A paper dealing with the bionomics of the pest is in course of preparation.

Following the promising results of three seasons' preliminary spraying experiments, extended trials were laid down in 1931 on both raspberries and loganberries. The main

objects were (1) to confirm certain observations made on the life history and thus to find optimum dates for spraying, and (2) to test the value of Derris preparations against the larvæ. A Derris preparation has now for several years given very good control, in 1931 reducing the average infestation of loganberries from 66.3 to 14.6 per cent. and of raspberries from 78.3 to 5.6 per cent. The total weight of the loganberry crop was almost doubled, and the weight of marketable fruit increased from 24 to 80 per cent. by two applications of Derris. Cost of spraying figures were obtained from a four acre Lloyd George plantation which was sprayed commercially.

Promising results were obtained with a cheap home-made Derris dust and attention will now be given to the standardization of such spray mixtures. A report on the season's work is awaiting publication (D75), and previous season's work has been described in a progress report (D69). (W.S.)

Insect Transmission of Raspberry Mosaic.

An infection experiment with potted plants of two varieties (Lloyd George and Baumforth B) has been carried out with two species of aphid (*Amphorophora rubi* Kalt. and *Aphis idaei* V.d.G.). (W.S.)

Capsidæ.

A winter spraying trial, planned on statistical lines, against the Apple Capsid Bug (*Plesiocoris rugicollis* Fall.) was carried out on a commercial farm. A considerable measure of control was obtained by the use of certain petroleum and tar-petroleum washes. The same sprays were also applied to strawberries, gooseberries and red and black currants to obtain information as to the damage likely to be done to undercrops where winter washing for Capsid is employed. The significance of certain small differences remains to be examined before the results are published. (W.S.)

HOPS

Commercial Varieties.

Clonal races of the most important have now been established, and are available for experimental purposes.

Cultural Trials.

Different distances for planting and the training up of various numbers of bines per hill are being tested on Seedling L21. The crop from these trials has now been recorded for the second season and as the plots have now come into full bearing it was possible to obtain the weight of dried hops from each plot.

Very marked effects of the treatments on both the quantity of the crop and the size of the cones has been noted.

The question of the effect on the yield of the *number of bines* trained up each string is still rather doubtful, though where one bine is trained up, the cones are markedly larger than in the case of two or three bines per string. Closer planting has again given the higher yields *per plot*, although the yield *per hill* is reduced by close planting. Where the hills are planted 3 feet apart in the rows the size of the cones is considerably reduced in comparison with 9 feet and 6 feet planting. It is intended to continue this trial over a period of years in order to discover whether the above results will be borne out under varying seasonal conditions, and with different varieties.

Half an acre of the Seedling OP21 (Oregon Cluster ×English Male ×English Male) has been planted this autumn and will be used for studying the effect of hard and light pulling of the bines combined with close and normal distance of planting. This trial will also provide material for brewing tests, and a source of sets for distribution to growers.

Another half acre of land has been planted with clone races of three strains of Fuggles and will be utilized for testing two degrees of severity of cutting the hills, as well as to ascertain if there is any variation in cropping of the " strains."

Pot Culture Experiments.

These experiments have been in progress for three years and have now been brought to a conclusion. Valuable and consistent diagnostic characters of foliage and growth closely associated with deficiency of certain elements of nutrition have been recorded. Mr. Burgess of S.E. Agricultural College, Wye, is kindly undertaking the chemical analyses of the plants grown under the various treatments. A report on the experiment is in preparation.

New Seedlings.

Twenty-two of Professor Salmon's new seedlings have been planted out, and a corresponding number of varieties not worthy of retention have been grubbed to provide room for the new selections.

Nearly 200 seedlings were recorded and dried separately in 1931, and bottle samples for resin analyses were taken from over 100 varieties.

Of the early varieties in 1930, X35 maintained its position in being richer in preservative substances than the Bramling. Amongst the midseason hops, seven

varieties proved richer than the best commercial variety (Mathon) and three out of the seven had not been previously tested. In the late hops, twelve varieties proved richer than the best commercial variety (Canterbury Golding). Three seedlings were of greater preservative value than the richest American hops, one of these varieties (C9a) has now exceeded the richest hops for three successive seasons. This work is being carried out in collaboration with Professor Salmon, who has issued a report (B17), and Mr. Burgess, of the S.E. Agricultural College, Wye.

Several of the best of these seedlings are now being planted in bulk to test their suitability for introduction to commerce.

Incidence of Downy Mildew.

The wet season provided ideal conditions for the spread of the fungus and the attack of the " spike " form of the disease in the spring and summer of 1931 was the severest yet recorded at East Malling.

" Spikes " first made their appearance at the beginning of May and continued to appear in large numbers throughout the summer until July 15th when the gardens were sprayed with Bordeaux mixture. It was necessary to go round the gardens every week in order to keep the " spikes " removed. A feature of the season was the large number of " spikes " formed in the axils of the leaves during July.

Two sprayings with Bordeaux mixture were given (July 15th and August 12th) which gave a satisfactory control of the disease on the cones, except in the case of certain varieties with a large amount of " head " to their bines. A powerful blower is required in such cases. (F.H.B.)

Section III

PRELIMINARY RESEARCH REPORTS

NOTES ON CERTAIN PLANT DISEASES OBSERVED IN 1931*

By H. WORMALD and R. V. HARRIS.

Of the diseases which came under our notice in 1931 those deserving special mention are the following :

Incomplete Lignification of Walnut Shells.—Many enquiries were received with reference to a trouble in walnuts resulting from incomplete development of the shells, so that portions of the shell did not harden up sufficiently to protect the kernels, thus rendering the nuts unfit for storage. In some cases the lower half of the shell was completely formed while towards the apical end of the nut the shell was still soft at harvest time ; when such nuts were allowed to dry two holes appeared in the shell, one on each side of the apex, and they had the appearance as though they had been pecked by birds. This incomplete lignification was one result of the dull rainy summer ; there was so little sunshine that the normal development of the woody shell was arrested. Such a condition is not likely to recur except in very dull summers.

Bacterial Blight of Walnuts—its Distribution in Britain.—This disease, caused by *Pseudomonas Juglandis*, was first noticed in this country in 1925 when it appeared at East Malling on certain young trees that had recently been imported for experimental purposes. Since then established trees in other parts of the country have been examined† in order to ascertain whether the outbreak at East Malling was an isolated case or whether the disease was to be found elsewhere in Britain. In 1930 it was found at Rainham (North Kent) and in Worcestershire, and last year (1931) bacterial spots were seen on leaves of trees at Wye (Kent), Croydon (Surrey) and Beckley (Sussex) ; the trees at Beckley showed infection not only on the leaves but also on the fruit. Thus up to the time of writing the disease has been found in six localities in England, three of them in Kent.

Multiple Canker Infection on Apple Twigs.—Canker in apple trees (*Nectria galligena*) was more general than usual and infection of young twigs was common. Apple twigs of the variety Easter Orange received from Marlborough were very severely cankered ; one twig had no less than seven cankers, five of these at successive nodes. Some of the cankers had girdled the twigs which were killed in consequence.

An Apple Rot.—In previous Reports‡ of this Station reference was made to an apple rot caused by *Gloeosporium album*. In those instances the rot was seen on the fruit during storage, and this fungus is generally considered to be one affecting stored fruit only. In July, 1931, however, Lord Grosvenor apples, received from Devonshire, showed saucer-shaped blemishes, nearly half an inch in diameter, bearing the fructifications of *Gloeosporium album*. That this fungus is able to attack apples not only in the

* A more detailed account of the diseases observed during the year has been published in the *Gardeners' Chronicle* for March 12th and March 19th, 1932, pp. 207-8 ; 224-5. Portions of that article are incorporated in the present Notes with the Editor's permission.

† This survey is being made by Miss J. B. Hamond.

‡ Annual Report for 1924, p. 115 and Annual Report for 1925 (II. Supplement), p. 78.

store but before they are picked, and while they are still growing, is worthy of notice. As in the case of other rots caused by parasitic fungi the fruit showing these blemishes should be removed and burnt where such a procedure is possible.

Sooty Blotch of Plums.—This disease (caused by the fungus *Gloeodes pomigena*) is chiefly known from its attack on apples and pears, but recently (1930) it was found on plums at East Malling. In 1931 it again appeared on the variety Warwickshire Drooper; the fruit bore dull dark blotches which in some cases nearly covered the fruit, making them quite unfit for market.

*Brown Rot of Morello Cherry.**—Observations, made at East Malling and in other localities of Kent, indicated that brown-rot blossom wilt of Morello cherries was very severe in 1931, and further, that much of the infection that year occurred before the flowers opened. Thus on the plots at East Malling, it was noticed that many twigs were dying about the time the trees were in full bloom and an examination of such twigs showed that in each case infection had arisen through flowers which were still in bud; such infected flower-buds bore the *Monilia* fructifications of the brown-rot fungus, *Sclerotinia cinerea*. All these infected twigs were cut away, but about a fortnight later other twigs were seen to be wilting and in this case it was found that infection had taken place through the open flowers. Thus there were two periods when flowers had become infected, one while they were in bud and the other when they had opened.

Bacterial Canker of Morello Cherry.—Bacterial Canker has been responsible for great losses in plum† and cherry plantations in recent years. Morello cherries are attacked less frequently, but in 1931 several cases of Bacterial Canker were observed on the trial plots of Morello cherries on this Station. The infection was mostly on young branches so that comparatively little damage was caused. On one tree, however, the main stem became infected and the tree had to be cut down. An organism which was isolated from the stem canker appears to be identical with *Pseudomonas mors-prunorum*, the cause of Bacterial Canker in plum trees, but further work is necessary for confirmation of this point.

Verticillium Infection of Morello Cherry.—During the summer of 1931 one of the trees on the Morello plots showed symptoms bearing some resemblance to Bacterial Canker for the leaves on one main branch turned yellow long before the period when the foliage would assume its autumn tints. No canker could be found on the affected branch, however, but on cutting the branch across it was seen that a sector of the wood was discoloured. Fungal hyphæ were found in the wood vessels of the discoloured tissues so culture plates were prepared and the fungus, when isolated, proved to be *Verticillium Dahliae*. This fungus, known as a parasite of many kinds of trees and shrubs in various parts of the world, has been shown to be the cause of Blue Stripe Wilt of raspberries‡ in Britain, but apparently it has not been recorded previously as a parasite of Morellos in this country, although it has been found on this host in Holland.

Raspberry Diseases.—Cane Blight (*Leptosphaeria Coniothyrium*) is becoming increasingly prevalent and has recently caused considerable damage to plantations of certain varieties of raspberry. Serious attacks have been recorded during the year on the varieties *Bath's Perfection*, *Reader's Perfection*, *Pyne's Royal*, *Red Cross* and *Goliath*. There is evidence that the disease may be controlled to some degree by the early removal and destruction of cankered canes in the spring and autumn. It is not sufficient to break such canes away; they must be cut off as close to soil level as possible. The

* For a more detailed account of this outbreak see the *Journal of Pomology and Horticultural Science*, IX, 1931, pp. 232-237. See also p. 57 of this Report.

† See page 70 of this Report.

‡ See previous reports of this Station, particularly the Report for 1924, pp. 126-133.

prevalence of infections on the crowns of the stools, however, indicates that some form of spraying will be necessary to give complete control and experiments are on foot to test such methods.

During the year additional evidence was forthcoming that the unchecked spread of *Mosaic Disease* is responsible for the progressive deterioration of the vigour of certain well-known commercial varieties, notably *Lloyd George*. In planting up such varieties the greatest precautions should be taken to obtain a sample of cane which contains a low percentage of infected plants. Experiments to determine the possibility of raising and maintaining supplies of virus-free cane of such varieties as *Lloyd George* are in progress at the Research Station and so far have yielded promising results. That the rate of spread of mosaic infection and the susceptibility of varieties may differ in different localities was indicated in the case of a plantation of *Lloyd George* in a private garden in Monmouthshire, where every stool was found to be infected with the disease and worthless.

Loganberry Diseases.—The cropping of many plantations of loganberries in the Weald of Kent and elsewhere was seriously affected as a result of the heavy infection of the canes with Cane Spot (*Plectodiscella veneta*) in 1930. A further attack occurred on the new canes in 1931 but generally it was not so intense as that of the previous year. This disease which appears to be becoming an increasing menace to loganberry growers also occurs on the raspberry, and in certain seasons reduces the crop of susceptible varieties drastically. In the latter case previous experiments had shown that an adequate control can be obtained by one (or sometimes two) seasonal sprayings of the fruiting cane with lime-sulphur or Bordeaux mixture.* In 1931 initial spraying experiments against the disease on loganberries, based on the schedule used successfully on raspberries, showed that a degree of control (but by no means complete) can be obtained by a single application of lime-sulphur (at 1 in 10 or 1 in 15) in the spring. In addition, the examination of seriously diseased plantations provided evidence that the attack of the disease was encouraged by certain methods of training in common use. Experiments with modified spraying schedules, and a comparative trial of modified methods of training in relation to the incidence of the disease, have been planned for 1932.

Infections of the basal portions of loganberry canes with Spur Blight (*Didymella applanata*) were recorded but there was no evidence that the attack in any case had affected the development of the canes to any appreciable extent.

Blackberry Diseases.—A very serious disease of varieties of cultivated blackberry has recently come to our notice and is temporarily referred to as " Reversion." The initial symptom is a failure of a large proportion of the flowers to set fruit. This is followed by an excessive branching and stunting of the new growths of cane and ultimately by the complete death of the plant. The *Cut Leaf* variety is extremely susceptible to this disease and in certain plantations of this variety examined during the year the greater proportion of plants were found to be infected. Cases have also been recorded in plantations of *Himalaya Giant* but the latter appears to be much more resistant than the former variety. Experiments are in progress at East Malling to investigate the possible virus nature of this disease but meanwhile it would be advisable, as a precaution against possible infection of healthy plants, to remove and destroy those showing the above symptoms.

Infections of *Himalaya Giant* and the *Laxtonberry* (a hybrid variety) with Blue Stripe Wilt (*Verticillium Dahliae*) were recorded during the year. Plants of the *Laxtonberry* severely infected with Spur Blight (*Didymella applanata*) were also found.

* See *Journal of Pomology and Horticultural Science*, 1931, IX, pp. 73-99.

Attacks of Rust (*Phragmidium violaceum*) on cultivated blackberries occurred generally but were not as severe as those of the previous two years.

Finally, serious economic attacks of a disease caused by the fungus *Septocyta ramealis** were recorded on a cultivated " wilding " blackberry and on the variety *Sherlock Junior*. This disease appears during the winter as dark purple blotches on all parts of the canes and the infected portions die or become " blind." Experiments carried out in 1931 on the control of the disease by modified training methods and by spraying have given promising results.

Strawberry Diseases.—Late in 1930 our attention was drawn to a serious disease, the leaf-symptoms of which correspond in many respects with those of the disease in America known as *Strawberry Xanthosis* or *Yellows* and described by Plakidas. The symptoms were associated with a sterile condition of the affected plant and ultimately with its death. Diseased plants were found to be infested with the Strawberry Tarsonemid Mite and in certain cases with the Strawberry Aphis (*Capitophorus fragariae*) but there was ample evidence that the main symptoms observed were not the result of direct injury by either of these pests. Experiments commenced in 1931 to investigate the possible virus nature of the disease by the method of grafting yielded some striking evidence in support of this supposition, and will be continued in 1932. The methods of grafting tested have recently been described elsewhere.†

A severe attack of *Armillaria mellea* occurred in East Kent during the year, on a three year old plantation of the " Paxton " Strawberry. The incidence of the disease may be accounted for by the fact that the ground was only cleared from underwood the year before the runners were planted. The disease was first noticed during a brief spell of warm weather in August when the foliage of a number of plants withered. In September a large proportion showed symptoms of attack and on lifting such plants, rhizomorphs (or the " bootlace stage " of the fungus) were found attached to the roots. The attack on the main crown, in a number of cases, stimulated the growth of subsidiary crowns. A previous record of this disease in the Long Ashton Report for 1927 states that the attack occurred on plants already enfeebled with age. It is interesting to note that the fungus can also cause damage in young vigorous plantations.

In October young strawberry plants were received which bore a white felty layer of fungal mycelium covering the crown and bases of the leaves. The plants were very stunted and this was probably due to the presence of this felt-like covering which prevented the normal development of the plant organs. The white felt proved to be the sterile above-ground mycelium of *Rhizoctonia Crocorum*.‡ This fungus is a parasite of a number of cultivated herbaceous plants but we have not previously met with it on the strawberry. When it occurs on the roots (as on carrots) it usually produces the minute sclerotia-like bodies known as " corps miliaires." Last year it was found parasitizing the roots of celery in this way.

Summary.

The " Notes " comprise brief descriptions of the more interesting diseases met with in 1931.

* This fungus was referred in a previous article (East Malling Res. Sta. Ann. Rep. for 1928-30, II. Supplement, p. 138) to the genus *Septoria* but was subsequently identified as *Septocyta ramealis* by Miss E. M. Wakefield.

† See *Journal of Pomology and Horticultural Science*, 1932, X, pp. 35-41.

‡ Identified by Miss E. M. Wakefield.

NOTES ON INSECT PESTS FOR THE YEAR 1931

By A. M. MASSEE.

The Red Spider Mite (*Tetranychus Telarius* L.).

The Red Spider Mite is known to occur on most kinds of top and soft fruits, it is also found on vegetables and greenhouse plants. The severity of attack on plants and trees varies from season to season according to climatic conditions. This fact is well known, but it is not always clear why sudden outbreaks of this pest appear in most unlikely places.

Some interesting examples of sudden outbreaks of this pest were noted in strawberry plantations, during March and April, at Marden, East Farleigh and West Malling. Samples of strawberry plants were examined from these plantations earlier in the season, and the red hibernating forms of the Red Spider Mite were not detected on the leaves or in the crowns of the plants. As a matter of fact the plants were examined to discover whether the Strawberry Tarsonemid Mite was present in the crowns. The plantations were visited again in March and April and it was noted that bad outbreaks of the Red Spider Mite occurred in each field. The reason for these outbreaks may be accounted for as follows. The strawberries were planted where hops had been growing previously. The hops had been grubbed in the autumn of 1929 and the ground was prepared for the strawberries. When the hops were grubbed, the Red Spider Mites, which were known to be present in hop gardens, migrated from the hop bines and established themselves in the soil for the winter. In the spring the mites left their winter quarters in the soil and commenced to attack the newly planted strawberries during the latter part of March and in April. A careful examination of the soil at East Farleigh showed that many colonies of red mites were present in clods of earth, and some remained there until the middle of April. Others had migrated to the strawberries some weeks earlier.

Similar instances of attack have been noted where strawberries follow black currants. Black currants are known to be very susceptible to Red Spider attack, especially late in the season ; and during the winter the mites hibernate in the soil under the bushes. If the bushes are grubbed and strawberries are planted in their place, the strawberry plants very frequently suffer from mite attack.

The Common Swift (*Hepialus lupulina* L.).

Another very interesting example of strawberry plants being attacked and killed by insects following the planting of the variety Royal Sovereign on hop land is as follows. Part of a hop garden which had never been very prolific was grubbed and strawberries were planted in the same ground. The one year old strawberry plants did not grow normally, and many were dying off in some unaccountable way. On examination it was found that the roots of the plants were being attacked by the larvæ of the Swift Moth or " Otter " as it is sometimes called by hop growers. The larvæ bored into the crowns of the plants from underneath, caused the plants to wilt, and eventually die. Nearly every plant was being attacked by one or more grubs. An examination of the remaining part of the hop garden adjacent to the strawberries showed the roots of the hops were also badly infested by the larvæ of the Swift Moth. It is considered the roots of the hops were numerous and sturdy enough to withstand serious injury by these

larvæ, but as soon as some of the hops were grubbed and strawberries were planted in their place, the larvæ attacked the plants before they became established, and so destroyed them.

The Hop-Damson Aphis (*Phorodon humuli* Schr.).

The Hop-Damson Aphis usually lays her eggs during the latter part of September and in October on the spurs and young growths of plums and damsons. This year, however, eggs were being deposited as late as the second week in December at East Malling. A survey of the pests in an orchard was being made between the hours of 10 and 12 p.m. on Saturday, December 12th, and the aphides were noted to be busily engaged in laying their eggs on the spurs. Egg laying was not noticed the following day or subsequently. It would be interesting to know whether this late oviposition period, which would appear to be very unusual, was brought about by the very mild conditions for the time of the year.

The Woolly Aphis (*Eriosoma lanigerum* Hausm.).

The Woolly Aphis of apple is pretty well distributed all over Kent, especially in localities where some of the older types of plantations exist. In common with many pests the Woolly Aphis is very much more prevalent in some years than others. At the beginning of 1931 it was very scarce in the Maidstone area, and only a limited number of scattered colonies could be found on trees where this insect usually abounds. Orchards were comparatively free from this pest until August and from that time onwards it kept increasing. By the end of August and in September many orchards were severely infested by Woolly Aphis and particulars and information regarding this insect were requested from growers in many parts of Kent and Sussex. It is possible that the wet summer delayed the increase of the aphides until late in the season ; and that the predaceous insects such as the Two Spot Ladybirds, the Seven Spot Ladybirds, and the Lace Wing Flies, which were particularly common last year, also tended to check the spread of the Woolly Aphis earlier in the year.

The Fruit Tree Red Spider (*Oligonychus ulmi* C. L. Koch.).

The Fruit Tree Red Spider behaved in a similar manner as the Woolly Aphis. The Fruit Tree Red Spider was not abnormally common early in the season, but by August and September general outbreaks occurred on apples and plums in many parts of Kent and Sussex. Even orchards which received the routine lime-sulphur sprays were affected late in the season. There does not appear to be much correlation between Fruit Tree Red Spider attacks and sunny warm weather, since several orchards were badly infested all the season, even during the rainy period. A good example of this was seen at Sevenoaks. The plum trees were so badly infested that they shed most of their foliage in August.

Another interesting point in regard to the Fruit Tree Red Spider has been observed. The fact that the trees in a plantation may be literally smothered with red eggs of this mite during the winter months, does not necessarily mean that there is going to be a very severe outbreak the following spring. In some seasons the infertility or mortality of the eggs is very great, and the proportion which develop is small in comparison to the total number of eggs present. This fact was noticed in many plantations last Spring.

An Apple Psocid (*Stenopsocus stigmaticus* Mhoff. and Labrum.).

Several enquiries were received about this insect during the winter of 1930-31.

The Psocid lays her eggs on apple twigs and shoots. They are deposited in groups, under finely woven silken threads, which resemble miniature spiders' nests which

have been somewhat flattened out. Some observant growers had noted these little egg batches on their trees while carrying out pruning operations, and naturally wondered whether the insects were harmful or not. As a matter of fact they are not harmful. On hatching the immature, and later on the adult Psocids feed almost exclusively on algæ and dead insects. Some species have been observed feeding on living insects; therefore this insect may be regarded as being mildly beneficial. Unfortunately it is destroyed by the application of tar-distillate winter washes.

The writer is indebted to Mr. J. V. Pearman of Bristol for the identification of this insect.

The Apple Fruit Rhynchites (*Rhynchites aequatus* L.).

The Apple Fruit Rhynchites, a small dull red weevil with a long snout, is commonly distributed in the South of England and is usually associated with hawthorn. It may be found on that host every year in the Maidstone district, especially during the flowering period. Some years ago it was reported damaging apple fruits at East Malling, and it sometimes occurs in fruit plantations in other parts of the country.

In 1931 a very serious outbreak occurred in an apple plantation at Swanley. The variety of apple Fearn's Pippin was chiefly affected, but other varieties did not escape entirely. The attacked fruits were quite unsaleable. The infestation extended over several acres of apples. The weevil bores holes into the developing fruits with her rostrum or snout, sometimes as many as twenty or thirty punctures being made in a single fruit. This type of injury is very similar to that obtained by sticking the point of a lead pencil into the flesh of the fruit. A typical example of the injury is shown in Fig. 1, which was taken from the orchard at Swanley. It is not definitely known why the weevils puncture the apples in this manner. At first it was considered that the punctures were made for the purpose of egg laying, but the examination of some hundreds of injured fruits rather dispelled this theory, since only some three or four eggs were found in the fruits. If this type of injury is going to continue each year, it will be very serious, and therefore an endeavour is being made to find out more about this pest under the local conditions at Swanley. It is curious that hawthorns and other hosts of this pest are not commonly found in the district.

The Apple Twig Cutter (*Rhynchites coeruleus* D.G.).

The Apple Twig Cutter is very closely allied to the Apple Fruit Rhynchites, but it is a little smaller and is bright blue in colour. Its habits are also very different, since it attacks the shoots of apples and plums and does not affect the fruits.

The Apple Twig Cutter has been known for many years and is usually associated with various species of Pomaceæ; the adult weevil is often found on the flowers of whitethorn in different localities in the Midlands and the South of England.

It has been reported as being a pest of apples and pears from time to time, but the damage caused by this insect has not been regarded as being really serious. In recent years, however, it has been observed causing damage in young apple plantations and in nursery beds containing one and two year old apple trees. Isolated attacks have been noted in Kent, but by far the worst attack was reported from West Sussex during June, 1931. It had been noted in the district in previous years.

The varieties Laxton's Superb, Cox, Worcester and Duchess Favourite, are more frequently attacked than other varieties of apples, but the weevil does not entirely disregard other sorts. The damage caused to the young growths of apples by the Apple Twig Cutter is very curious and also very typical. The adult weevil nibbles at the new growths, nearly always working at a distance of about three inches from the tip of the

shoot. After some time the tip of the shoot is practically cut off. Almost immediately the tip of the shoot begins to dry up, the leaves flag, and eventually the dried up stem falls to the ground. Directly the weevil has finished cutting the twig she lays an egg in woody tissue of the portion which will eventually become disconnected from the tree.

The twig cutting operations commence at the middle of May and continue until the end of June. A few late hatched weevils may continue twig cutting until the second week of July. Frequently as many as twenty-four shoots on some small Worcester trees were damaged, which amounted in some cases to the total amount of new growth. On other trees, all the shoots on one side were attacked, while the leaders on the other side of the trees were not damaged and they grew away quite strongly. This meant that the growth of the trees was very unbalanced, and that pruning measures the following winter would prove to be very difficult to carry out properly. A definite check to the trees, which lasts for several seasons has also been observed where this weevil has been at work. A typical example of the injury caused by the Apple Twig Cutter is shown in Fig. 2.

Eggs have been found in the shoots which are cut off and it has been observed that the egg stage is of very short duration. The small larvæ which hatch out tunnel into the pith of the withered shoots, they feed rapidly and it is considered that the larvæ mature in about fourteen days. In the laboratory it has been shown that the mature larvæ go into the soil to pupate, and that the pupæ remain in the soil until the end of August. At this period the adult weevils emerge. They make a small compact cell in the soil, and remain there all the winter. It is recognized that under field conditions the life-cycle of this weevil may vary considerably from that described above.

The Apple Twig Cutter has also been noted on Victoria plum, and although the attack is not severe at the present time, there is evidence to show that this pest is increasing on plums.

The writer is indebted to Mr. K. G. Blair, B.Sc., for the determination of the two species of *Rhynchites*.

Summary.

Notes are given on some insect pests and mites observed during the year 1931. The Red Spider Mite is recorded as being injurious to strawberry plants, especially when this soft fruit is planted on the same ground as hops. The Swift Moth caterpillar has been observed to destroy newly planted strawberries on land where the strawberries have followed hops. Two species of *Rhynchites* are also recorded from apple, one species attacked the fruits and the other destroyed the new growths. The Fruit Tree Red Spider, the Woolly Aphis, the Apple Psocid and the Hop-Damson Aphis are also briefly referred to.

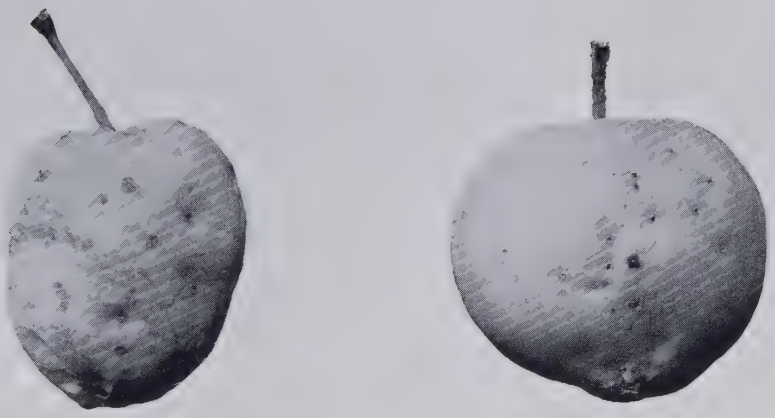


FIG. 1.

Fearn's Pippin Apples damaged by the Apple Fruit *Rhynchites*.

FIG. 2.

Typical example of damage caused by the Apple Twig Cutter. (Note branching and stunting of growth.) Variety: Cox's Orange Pippin.

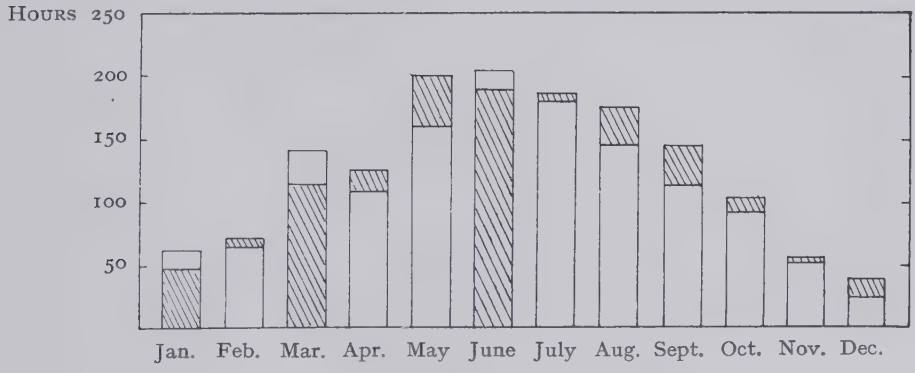
WEATHER CONDITIONS DURING 1931

By H. C. CHAPELOW and H. M. TYDEMAN.

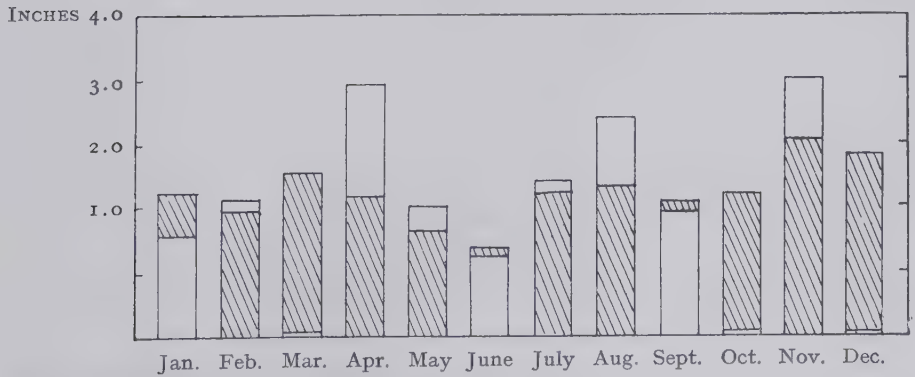
The weather conditions experienced during 1931 were, upon the whole, fairly average. Temperatures were somewhat low during the earlier months, February in particular being cold and wet. The blossoming season was rather late due to generally cold conditions during March. Despite low temperatures, March was sunny and open with, however, numerous ground frosts. Soil temperatures remained stationary throughout March thus retarding the commencement of vegetative growth. Where apples were in full blossom round about the 12th of May the weather was favourable to good setting, but in those districts where full blossom occurred during the week of the 19th the weather was adverse and unsatisfactory crops were obtained. No ground frosts occurred during the blossoming period. Upon the whole it may be said that conditions during the spring were favourable to plant growth. Throughout the summer both sunshine and rainfall were normal. September was somewhat cold and showery, November was very wet and October and December were unusually dry.

The total rainfall for the year was 23.89 inches—slightly more than 2 inches below the normal. The sun shone 1,350 hours, approximately 111 hours below the average for this district.

TOTAL SUNSHINE IN HOURS.



TOTAL RAINFALL IN INCHES.



Diagrams showing Total Sunshine and Rainfall during 1931 as compared with previous 17 years average. Shaded portion 17 years' average.

SUMMARY OF METEOROLOGICAL OBSERVATIONS DURING 1931.

	Temperature in Screen.					No. of Ground Frosts.	Rainfall.			Sunshine.			Soil Temperatures.		
	Mean Maximum.	Mean Minimum.	Highest.	Lowest.	Mean.		Total in inches.	17 years' average.	Heaviest fall in any one day.	Total hours.	17 years' average.	Average per day.	4 inches.	8 inches.	2 feet.
January ..	43.5	32.6	53	25	31.8	20	1.58	2.26	0.32	60.2	47.7	1.93	37.7	37.7	39.6
February ..	44.2	32.9	54	27	38.5	16	2.12	1.94	0.50	65.2	68.8	2.33	39.1	38.3	39.5
March ..	47.1	32.5	64	21	39.8	23	0.15	1.47	0.08	139.2	114.8	4.49	40.5	39.9	39.7
April ..	53.9	40.0	67	31	46.9	6	3.94	2.18	0.80	110.7	125.9	3.69	47.3	46.5	45.6
May ..	61.6	44.4	72	34	53.0	2	1.99	1.69	0.63	158.6	200.8	5.12	55.2	53.3	51.1
June ..	68.4	49.9	81	40	59.1	0	1.32	1.40	0.57	203.8	191.9	6.79	64.6	62.4	59.6
July ..	68.7	52.1	78	44	60.4	0	2.41	2.22	0.47	181.6	185.5	5.86	66.7	65.2	63.3
August ..	66.2	51.6	77	36	58.9	0	3.42	2.32	0.72	144.8	176.2	4.67	63.2	62.5	61.8
September ..	60.6	44.0	70	34	52.3	1	1.94	2.02	0.61	114.7	147.2	3.82	57.3	57.0	57.2
October ..	57.6	39.0	68	16	48.3	11	0.51	2.28	0.28	93.0	100.2	3.00	50.5	51.1	52.9
November ..	52.2	38.6	61	30	45.4	13	4.09	3.11	1.64	50.8	57.8	1.69	45.3	45.4	46.8
December ..	46.0	37.0	60	23	41.5	12	0.40	2.93	0.12	27.5	38.1	0.89	41.7	42.0	43.9

Section IV

BULLETINS FOR FRUIT GROWERS

POMOLOGY

SOME ASPECTS OF MORELLO CHERRY CULTURE*

By N. H. GRUBB, A. C. PAINTER and H. WORMALD.

Varieties.

The Morello cherries, of which there are several varieties, form a distinct section of the acid cherry species (known to botanists as *Prunus cerasus*). Their fruit is characterized by its dark colour when fully ripe, and its dark reddish juice. The French name " Griotte " and the German " Weichsel " apply to this group.

Whilst the Morellos usually grown in the British Isles are supposed to be of two varieties only—the " common Morello " and the Wye Morello or Morella—it is probable that there are several closely similar sorts grown in various districts as " common Morello." Some growers speak of a " Crown Morello," but it has not been possible so far to learn of any distinctive characteristics of this or other " strains." It is probable, however, that there are slight differences between different " strains " in time of flowering, time of ripening, size of fruit and perhaps other points. It is even possible that some may be more resistant to brown rot than others, but such differences may be due only to local conditions and not to variety or " strain." Both the Common and the Wye Morello have been shown to be self-fertile.

Stocks.

Trees of Morello can be obtained on either Mazzard or Mahaleb stocks. The Mazzards are sweet cherries (*Prunus avium*), and may be either seedlings or suckers from wild trees. In either case they are by no means uniform, and seedlings are often extremely variable. The Mahaleb stocks are almost always seedlings, and are also very variable ; they belong to a distinct species, Prunus Mahaleb.

Stock trials with Morello cherries, begun at East Malling in 1922, have already given some interesting indications. The trees on all stocks were grown as bushes on a two-foot leg and planted at 12 feet square. Under our conditions here, tending as they do towards vigorous woodgrowth in early years, this distance has already in the course of seven years proved altogether too close. Even under conditions where growth is not so vigorous, allowance should be made for the habit of the Morello, referred to later, of carrying its blossom mainly on last year's wood. Where close planting is resorted to, special methods of pruning are rendered necessary in order to maintain a supply of fresh shoots, without overcrowding the trees. The stocks under trial are a number of selected Mazzards, two selected Mahalebs and two selected acid cherry seedlings all propagated by layering for the sake of uniformity. It may be said here that whilst many Mazzards root quite readily from layers, it has not so far been possible to find in this country any Mahalebs or acid cherry seedlings which would root readily enough to be of real value for this purpose. At least two vegetatively raised varieties of acid cherry stocks are in common use overseas.

* Reprinted from the Catalogue of the Eighth Cherry and Soft-Fruit Show, 1931.

The two acid cherry seedlings so far tried are of no value as stocks for Morello. They dwarf the tree and reduce the cropping altogether too much. They may, however, prove to give useful dwarf trees when worked with sweet cherry varieties.

The stocks called " Common Cherry " by nurserymen are usually Mazzards ; but occasionally acid cherry seedlings have been offered under this name. Care is needed to make sure that Morellos stated to be on " Common Cherry " are on Mazzard and not acid cherry stocks.

The various selected Mazzards and the two selected Mahalebs have so far proved more or less satisfactory. The two Mahalebs have both given stronger trees in the Nursery than any of the Mazzards ; on one of them, the Morello trees are still (seven years after planting) bigger than any on Mazzard, but the latter are now rapidly catching up in size. Further, three trees out of eighteen on Mahaleb have developed an obscure " disease " resembling silver-leaf (*not* caused apparently by *Stereum purpurem*) and have been removed ; others show indications of the same trouble. No trees on Mazzard have so far behaved in this way.

Whilst the best trees on Mahaleb have so far cropped more heavily than on any Mazzard, it is feared that they may have a short life owing to this trouble. There are indications also that the trees on Mahaleb are more susceptible to brown rot than any of those on Mazzard. It is possible that for short-lived " filler " trees, Mahaleb stocks might prove satisfactory, but for longer-lived trees the preference should probably be given to Mazzard stocks.

PRUNING.

The Morello, like other acid cherries, produces its blossoms and fruits chiefly on shoots of the previous year's growth and not on spurs. This habit makes it necessary to prune for growth ; " spur pruning " is no use at all. Except on young trees, the buds on Morello shoots are usually single and are either wood buds or flower buds, not both. Young trees sometimes produce satisfactory wood growth from flower buds, but old trees do so very rarely. It is always best when pruning, to cut to wood buds if these are available, and, for this reason, it is desirable to leave the pruning until the buds begin to swell in spring, when it is easier to distinguish wood from flower buds.

For at least two years after planting, a moderate tipping of the leaders is desirable. Afterwards, the pruning consists of a moderate thinning out of the head, inward and crossing shoots being cut back to wood buds, which are often to be found near the base. If trees are left entirely unpruned, they tend to become so dense that the fruiting wood is nearly all on the outside, the centre consisting entirely of bare wood. Even a moderate thinning out prevents the development of this habit and enables the tree to fruit more or less in the centre.

DISEASE.

The great susceptibility to Brown Rot infection shown by the Morello cherry is one drawback to its cultivation. The fungus, *Sclerotinia* (*Monilia*) *cinerea*, infects the flowers and extends into the twigs which are, in consequence, killed back for a distance of from two to three inches to a foot or even more, thus causing many flowers to wilt which are not directly infected by the parasite. When the infection is very severe, nearly all the flowers on some trees may be destroyed in this way.

Infection often takes place through open flowers, but recent observations have shown that the fungus may also attack flowers before the petals open. Instances where infection through unopened flowers has caused much damage this year have been noted in several localities in Kent. The result of such infection becomes evident about the time the trees are in full bloom, when the blossoms on some of the twigs suddenly wilt.

Those flowers directly infected by the fungus become covered with fungal fructifications producing innumerable spores, while the tree is still in bloom ; they therefore serve as sources of infection for the flowers that are then open. Some of these become infected in their turn and there is thus a second wave of infection which becomes noticeable as the fruit sets, since it takes some days for the fungus to extend from the infected flowers down the flower stalk and into the twig. The infection of a single flower may, in this way, cause the death of most of the flowers on that twig, or even the whole flowering portion of the twig may be killed.

Such dead twigs, if left on the trees, will become sources of infection the next year, for the fungus passes the summer and winter within the twigs and produces fructifications, bearing numerous spores the following winter and spring, in time to infect the new flowers. These spores are very small (about one two-thousandth of an inch in length) and powdery and are easily carried about in the wind. It often happens, therefore, that infection occurs on trees at considerable distance from any obvious sources of infection. Almost invariably, however, the wilting twigs are most numerous on trees bearing dead twigs which had been killed by the fungus during the previous season.

It follows that the most sure means of controlling outbreaks of the disease in Morellos is the systematic removal of all dead or dying twigs ; this should be done as soon after the wilting is noticed as possible, for the withered flowers are then very conspicuous and indicate which twigs should be removed. If they are left until later in the summer, they become partially hidden by the foliage, and, if the operation is not carried out until winter, the dead twigs are not so readily seen and many may be overlooked.

It is very important that the trees should be gone over again when the buds are swelling in the spring in order to cut out any dead twigs which were missed the previous summer. These can be most easily seen a week or two before the blossoms open.

If there is a spell of dry weather during the period that the trees are in flower, there may be little infection ; nevertheless, the trees should be examined and if any dead or dying twigs are found they should be cut out, for a few such twigs, if left on the trees, may cause serious loss the following year if the conditions happen to be favourable for the fungus. Owing to the constant vigilance and immediate attention necessary in " brown rot " years, it would probably be unwise for anyone to embark on a large area of Morellos. The condition of standard and half-standard Morellos commonly found as filler trees amongst sweet cherries is usually eloquent of their behaviour where control is difficult and personal attention impossible.

When trees have been severely infected one year, and it is suspected that all dead twigs may not have been removed, the trees should be sprayed with Bordeaux mixture (8 : 8 : 100) as the buds unfold in order to check infection of the young flowers.

The same fungus also infects the young fruit, and this is another reason for advising the early removal of wilted twigs, although brown rot of the fruit is, as a rule, not very serious. The infected fruit may remain on the trees and become mummified ; as the " mummies " also serve as sources of infection, they, too, should be removed either at picking time or during the winter.

The nature of these precautions would seem to indicate that the " bush " form of tree is the most suitable for commercial plantings of the Morello.

A closely related fungus, *Sclerotinia fructigena*, the common brown rot fungus of apples and pears, also attacks Morello cherries as the fruit ripens. This again is not very noticeable unless the weather is very unfavourable as the fruit approaches maturity.

Another disease which is sometimes found on the Morellos is Bacterial Canker. This infection is occasionally on the stem, but usually it is on the one or two year old

branches, causing their death. It is not of very frequent occurrence, but the dead or dying branches should be removed as soon as the disease is observed.

Picking and Marketing.

On the stock trial plot at East Malling, the trees are picked over two or three times as the fruit ripens. The fruit is picked and marketed on the stalk, scissors being used for this purpose in order to obviate damage to the buds and to prevent stripping of the bark.

After the fruit has been picked, it is taken to the packing shed, where it is graded by hand into two size grades and marketed in either 6 or 12 lb. chips.

Judging from the prices received for the fruit during the past few years, Morellos would appear to be a paying proposition provided a reasonable crop is obtained. The following figures show the cost of picking and marketing the fruit from this plot in 1929 and 1930, when the trees were in their sixth and seventh year :

Cost of Picking and Marketing (per lb. of Fruit).

	d.
Picking	1.45
Grading	.14
Rail Charges	.27
Package	.35
Handling and Cartage	.03
Salesman's Charges	.57
	2.81

The actual cost of picking has been given, but is probably higher than it would be under ordinary commercial conditions owing to the crop from each tree having to be kept separate for recording purposes.

All the trees on the plot have been included in the above table with the exception of those on acid stocks referred to above.

It should be noted that the figures quoted here give only the cost of picking and marketing. It will be easily realized, after all the emphasis that has been laid on the need for close attention to detail, particularly in the matters of brown rot control, that the total cost of production per acre is a very considerable item, especially in seasons when brown rot is severe.

Summary.

The Morello cherries form a section of the Acid Cherry species (*Prunus cerasus*). Whilst several varieties are recognized there may be two or more closely similar varieties grown as " Common Morello."

Morello cherry trees are obtainable worked on either Mazzard or Mahaleb stocks. The former seem likely to give longer lived and healthier trees, whilst the latter grow more rapidly when young, and may crop more quickly.

Morello trees bear their fruit mainly on shoots of the previous year ; pruning must therefore be designed to produce new growth in sufficient quantity.

The most serious disease of Morello is Brown Rot, which chiefly attacks the blossom. It is very important to cut out every bit of dead wood before the blossoms open in order to remove sources of infection. Bacterial Canker also sometimes attacks Morellos and should be cut out when seen.

Data collected in marketing the Morello crop at East Malling show that the cost of picking and marketing the fruit was somewhat below 3d. per lb.

Brown Rot Infection of Morello Cherry. Three twigs killed last year and three this year.

THE PRUNING AND RENOVATION OF APPLE TREES*

By N. H. GRUBB.

Although pruning has come to be a routine operation on the majority of fruit farms where apples are extensively grown, many growers, more especially those with whom fruit is a side line, still fail to realize its advantages. Growers whose trees are mostly standards, in particular, often question whether the benefits of pruning justify its considerable expense. The object of this article is to show in what ways the apple grower gains by regular pruning, and briefly to describe the methods best adapted to apple trees of different form, age, and variety.

It is generally agreed that young fruit trees require considerable pruning soon after they are planted, and for at least a year or two afterwards.† On methods also there is at this stage general agreement. It is necessary to shorten or " tip " the " leaders " (i.e. the shoots intended to form or extend the branches) fairly severely at least once or twice, in order to get strong stout shoots, well spaced, to form the framework of the future tree. This applies to standards as well as to bush trees and to plums, cherries, and pears, as well as to apples. It is the later treatment, and particularly that of bearing standard trees, about which growers disagree most strongly. The greater part of this article will therefore deal with the pruning of standard trees of bearing age.

It will be based mainly on the results obtained in the Apple Pruning Plot at East Malling. This plot was planted partly in the winter of 1913-14, and partly a year later ; the trees are thus eighteen and seventeen years old from planting respectively. One quarter of the trees of each of the fifteen varieties in the plot have been treated, as regards pruning, in each of four ways : (1) Unpruned ; (2) Thinned out, or " Regulated," without leader tipping ; (3 and 4) Leader tipped, with laterals " spurred " to two different lengths. Of these treatments, 1 and 2 are, except in the case of young trees, typical of the usual pruning in standard orchards, whilst 3 and 4 are more commonly applied to bush and low half-standard trees.

Pruning the Young Trees.

The chief principle governing the pruning of young trees is the discovery, first recorded by Pickering at Woburn, and since then amply confirmed at East Malling and elsewhere, that any dormant pruning of the branches of a young tree (as opposed to summer and root-pruning) tends to delay its cropping.

There are, no doubt, occasional exceptions. In such cases the unpruned trees quickly become too weak to " set " an adequate proportion of their blossom ; lightly pruned young trees, though producing less blossom, may sometimes bear more fruit. Nevertheless it may be said in general that *the more severely one prunes a young tree the longer one will have to wait for a crop.* There are great advantages in well shaped trees with branches well furnished with spurs, and stout enough not to need much shoring up when loaded with fruit—the chief gains from severe pruning of the young

* Reprinted from *Berkshire Farmers' Year Book*, 1932, under the title " The Pruning of Apple Trees with Special Reference to Standards."

† It is not possible to discuss here that very thorny question, whether freshly planted trees should be pruned at once or left for a year.

tree ; but one can easily sacrifice too much in early cropping with these ends in view. This is particularly the case with " filler " trees, planted to make use of the space between the permanent trees for say ten, fifteen or twenty years. Fillers are intended to have a short and *useful* life ; overpruned fillers often fail to crop heavily until only a year or two before they are due to come out. In such circumstances the grower is strongly tempted to leave his fillers too long, to the lasting injury of his permanent trees.

At the same time it must be remembered that young trees of quick cropping varieties (the sorts chiefly used as fillers) may sometimes be unduly checked by *too early cropping*. A heavy crop invariably checks growth ; if we allow our trees to crop heavily before they have made adequate growth, they may take much longer than is desirable to fill the space allowed for them. Except in the case of very dwarf filler trees, cordons, and the like, the tree's early job is *to grow*. One cannot expect a paying crop until the trees fill a considerable proportion of the space ; it will pay to sacrifice something in early cropping, in order the sooner to secure a really heavy yield per acre.

Methods with Young Trees.

Up to bearing age, apple tree pruning consists of :—

(1). Severe leader tipping for one or two years (sometimes longer) in order to get strong stout shoots to form the main branches of the tree.

(2). Less and less leader tipping (and in many cases none, after the fourth or fifth year) to allow the tree to form its head, and come into cropping before it completely fills the space allowed for it. This must be accompanied by more or less thinning out of the head, in order to space the branches adequately and to prevent overcrowding. The strong new shoots, and very strong growths from " spurs," are preferably cut clean out ; weaker shoots may be " spur pruned " to from three to five inches the first time they are cut, and afterwards to one inch or less until fruit buds are formed freely ; thereafter they are shortened right back to the fruit buds.

(3). At this stage allowances must be made for differences between different varieties. Young trees of spreading varieties, like Lane's Prince Albert, and to a less extent Bramley's Seedling and Blenheim Orange, must usually have the leaders tipped (if at all) to *upward* buds to keep the branches from growing too horizontally ; with upright varieties, like Worcester Pearmain, the tipping must be to *outward* buds in order to spread the tree. Some varieties, again, like Cox's Orange, if left with no leader tipping, tend to become weak and unhealthy even before they crop ; in such cases some leader tipping is needed right up to cropping age, and more after cropping begins. Still other varieties, like Worcester Pearmain, if left with no leader tipping when young, fail to furnish their branches with spurs ; one finds long branches, which ought to have numbers of spurs, entirely bare, and taking no share in the tree's production of fruit.

Varieties Suitable for Standards.

The following notes may be useful to those who contemplate planting standard apple orchards.

The varieties most planted as standards at the present time are *Bramley's Seedling* and *Grenadier*. The former is very vigorous and rather slow to crop ; it requires little leader tipping after the third or fourth year ; too much tipping is apt to make it over-vigorous and to delay its cropping unduly. The latter is less vigorous and quicker to crop, and consequently is suitable for " filler " trees ; it also makes a moderate sized permanent tree. Long leaders on young trees of Grenadier often have tip fruit buds, and must be at least lightly tipped to preserve the shape of the tree. Except for this, Grenadier usually requires little tipping, especially as a " filler."

Other varieties worth considering are Newton Wonder, Lord Derby, Annie Elizabeth, and Blenheim Orange. All these are vigorous and rather slow to crop; they require little leader tipping after the first few years. Blenheim Orange especially is very slow to crop and will make a good tree (and incidentally crop sooner) with less pruning than almost any other sort.

Worcester Pearmain is still sometimes planted as a standard (usually as a " filler "), but it is generally considered to require too much pruning and spraying when mature to be quite satisfactory for the purpose. When young, it produces most of its fruit buds on the tips of laterals up to a foot or more in length; if all these are spur-pruned, cropping will be unduly delayed.

The Bearing Tree.

Whilst unpruned trees, at least in their early years of bearing, nearly always bear the heaviest crops, it does not follow that they bear the most *valuable* crops. In these days especially, when markets are apt to be glutted with fruit of mediocre quality, it is the high quality fruit that brings the returns. And this is where pruning counts most of all. Like spraying, it is becoming an essential routine practice, and cannot be neglected for more than a year or two, without the risk of a serious reduction in the value of the crop. Even on those exceptional farms where unpruned trees continue for years to give paying crops, it is practically certain that some pruning would increase the returns.

Pruning the mature tree increases the proportion of high-grade fruit; in fact, without pruning, the proportion of " extra fancy " and " fancy " apples is often very low. Its effect is seen in several directions:

(1). It makes the fruit larger. A large proportion of the fruit of unpruned trees usually comes in the smallest grades; of some varieties the bulk of it is apt to be too small to market, except in bags for jam.

(2). It improves the colour of coloured varieties. Although in this respect pruning can be overdone, the bad effect of overpruning on colour is not likely to last more than one or two years. Trees in grass, however, usually produce well coloured fruit regardless of pruning.

(3). It makes the efficient spraying of the trees easier. Unpruned trees often become so mop-headed that it is hardly possible to spray them thoroughly, even with the expenditure of an undue amount of time and spray mixture. They are apt to become breeding grounds for pests and diseases.

(4). It removes insect eggs and fungus spores, and probably makes the trees actually more resistant to such diseases as scab, canker and mildew.

(5). It makes it easier to pick the fruit.

(6). In extreme cases, where trees have become too weak to crop satisfactorily, pruning may considerably increase the crop. And, except in the early years of cropping, trees regularly pruned usually produce heavier crops than unpruned trees of the same age.

Some Actual Results.

All these results of pruning have recently been seen in the Apple Pruning Plot at East Malling. The " unpruned " trees (see above) were left untouched until the winter of 1929-30, i.e. for thirteen and twelve years for the two parts of the plots respectively. Cankered and broken wood was of course cut away, and several varieties had their low branches trimmed up to allow of cultivation; otherwise no pruning was done.

By 1929 the unpruned trees of most of the varieties had become very unsatisfactory; they produced large quantities of very small fruit, often only in alternate

years, and never more than a small proportion of good stuff. For example, in 1929, the last year before the "unpruned" trees were thinned out, those of Cox's Orange produced 54 lbs. per tree, 6 per cent. "Extra Fancy," 27 per cent. "Fancy," and 67 per cent. "C" grade. One of the leader tipped rows of Cox's, in the same year produced 65 lbs. per tree, 18 per cent. "Extra Fancy," 37 per cent. "Fancy" and only 45 per cent. "C" grade. Of certain varieties many of the unpruned trees were so dense headed that it was very difficult to control pests and diseases by spraying. And in many cases it was hardly possible to pick the fruit without breaking spurs and branches. It was therefore decided to thin out their heads, and in addition to "dehorn" some of them, in order to see whether they could be restored to a satisfactory condition.

The illustrations will give some idea of the appearance of the trees before and after pruning. In "dehorning," the taller branches were cut back by three feet or more, usually into five to eight year old wood. The cut was always made just above a fair-sized branch, as it has been found that this method reduces the subsequent growth of strong shoots and "watersprouts." All the varieties were treated in much the same way; but the denser headed trees of course had much more wood cut away than those which were already more open.

The crops of 1930 and 1931 have plainly shown how much the *thinning* was needed, even at this early stage; in several cases the dehorning has still further improved the results. It is surprising to find trees only fifteen to sixteen years old from planting—as these were at the end of 1929—showing benefit within two years after such drastic treatment. It would be still more surprising if we had not in some cases found that the pruning had temporarily reduced our returns.

As would be expected, then, the weight of crop has in many cases been reduced, sometimes very considerably, especially by the dehorning. But there are several cases where the thinning appears already to have *increased* the weight of the crop; and even a few of the dehorned trees seem, by comparison with trees pruned similarly throughout, to have borne more weight of fruit than they would have done if left untouched.

Effect on Fruit Size.

The most noticeable improvement is, of course, in the size of the fruit. Trees which before the pruning were producing little but smallest grade fruit, have given much more in the large grades and very much less in the smallest grade, often hardly any. In 1929, for instance, the "unpruned" trees of Cox's Orange produced on the average slightly over 50 lbs. of fruit per tree; $4\frac{1}{2}$ lbs. came in the three larger grades together, whilst the fifth and sixth grades (the smallest) took no less than 31 lbs. In 1930, the same trees (some having been thinned out, and others dehorned in addition), produced about 36 lbs. per tree, of which nearly 9 lbs. were in the three larger grades, and less than 7 lbs. in grades 5 and 6. Trees regularly pruned produced a slightly heavier crop in 1930 than in 1929, and their fruit was a trifle larger, in 1930, but not so much as to give an appreciable increase in returns.

In a year of glutted markets the improvement, even though obtained at the cost of some temporary reduction in quantity, would make all the difference between profit and loss; for in such years only the larger grades can be sold at a price which leaves any margin of profit.

The improvement in fruit size does not occur equally in all varieties, and it is usually greater, with a larger average reduction in crop, for the dehorned than for the merely thinned trees. But there are a few cases where the fruit has been *smaller*, and the crop *lighter*, since the pruning. It seems probable that in these cases our

pruning was too drastic. The trees had not become so weak as to need really severe thinning, and especially dehorning. The inference is that the treatment needed depends on the state of the tree. We thinned all our trees, of all varieties, roughly in the same way, regardless of their vigour ; we should have had better results if we had treated the weakest trees and the weakest varieties more drastically than those with more vigour. As a rule, alternate trees were chosen for dehorning, the weakest, where possible, being included ; but the alternate arrangement, and the inclusion of all varieties, led inevitably to the dehorning of some trees not weak enough to need it.

Effect on Fruit Colour and Scab.

The effect of the pruning on fruit colour, and on scab, has been recorded only for Cox's Orange and Rival. In each case it seems clear that the *thinning out* has considerably improved the colour of the fruit ; the dehorning has probably not improved it much further, and where vigorous trees were dehorned, it has, so far, actually reduced the colour. But this effect will probably soon disappear, unless the dehorning is repeated.

The fruit of all the trees has undoubtedly been freer from scab than it would have been without the pruning ; and that of the dehorned trees has been freer than that of the merely thinned trees. This is no doubt partly due to the more efficient spraying made possible by the pruning, but probably still more to a direct effect of the pruning on the health of the trees. The trees of these two varieties, before pruning, were not so dense headed as to be really difficult to spray thoroughly.

Methods with Bearing Trees.

The pruning of large standard trees is at best an expensive operation. Trees which have been left unpruned for a number of years, and which have nevertheless continued growing vigorously, as often happens with Bramley's Seedling and other strong growing varieties, are apt to be so dense that the cost of pruning is almost prohibitive. At the same time, such trees cannot be sprayed thoroughly, and much of their fruit is apt to be small and badly scabbed. The remedy is to prune them before they get into such a condition. " Little and often " is a much better rule than an occasional drastic pruning. Up to 1929, nearly every variety in the Pruning Plot at East Malling had given better returns where the trees were thinned out, without leader tipping, than where they were left entirely unpruned. In the case of weak and unhealthy varieties, like Cox's Orange, regular pruning is still more imperative. Such varieties, in its absence, soon become too weak and unhealthy to bear crops of high quality fruit. This is a powerful argument against the planting of such varieties as standards.

Strong growing varieties should as a rule have their heads thinned at least every other year. Where the biennial bearing habit is developed, pruning in alternate years may help to even up the cropping, provided it is done *after the OFF year*. With weak growing sorts, especially Cox's Orange, a considerable pruning every year is seldom too much ; it should include (with bearing trees) a fairly severe leader tipping, and where leader growth is weak, a moderate dehorning to encourage such growth. Coloured varieties, in general (if not in grass) will usually give better coloured fruit if pruned more or less every year.

Methods of Thinning Dense Trees.

The question is often asked : " Is it better in thinning a dense tree to take out a few large branches or many small pieces ? " Where trees have been pruned at

frequent intervals they rarely become so thick-headed that this question arises. Wherever it does arise, however, the thinning out by many small cuts is strongly to be preferred. This method is much less likely to cause a rank growth of " water sprouts." And further, since large branches must nearly always be cut clean out, whilst small pieces can often be cut back to spurs or side shoots, the latter is much less likely to reduce unduly the bearing capacity of the tree. Nevertheless, the cutting out of a few large branches is almost always preferable to the complete neglect of the pruning, where considerations of time do not allow of the adoption of the better method.

Dehorning.

Dehorning is needed chiefly, as stated above, by weak trees to increase their vigour, thereby enabling them to produce larger (and often more) fruit. Varieties which are normally vigorous, like Bramley's Seedling, may for various reasons become so weak as to need dehorning. But it rarely happens that all trees of such a variety in an orchard are equally weak. If some trees are distinctly more vigorous than others, it may be advisable to omit them from the dehorning.

Dehorning is also useful where trees have become so tall as to be difficult to pick or spray. In such cases it often pays to lower the trees by as much as eight or ten feet ; some temporary loss of crop will be more than paid for by easier handling.

In dehorning trees, it is always well, as stated above, to make each cut just above a fair sized side branch. If the cut is made elsewhere, the result, with many varieties, is apt to be a large number of strong shoots, just below the cut ; these must be rigidly thinned out in the following winter—a lengthy operation. Following dehorning, many varieties, unless the trees are exceptionally weak, are likely to produce a crop of strong " water sprouts " in the centre of the tree and along the larger branches. Where very strong these should usually be cut clean out, except where a new branch is needed to fill a gap in the tree. Weaker shoots may be spur pruned, unless the branches are already well furnished with spurs. It has sometimes been suggested that water sprouts make " unfruitful " wood ; there is apparently no reliable evidence, however, to support this view, and cases are known where trees with heads entirely regrown from water sprouts have cropped well. And some growers have even dehorned their trees solely to get a crop of water sprouts, so as to furnish the bare branches with spurs.

Summary.

The results of different methods of dormant branch pruning, as applied over a number of years to apple trees at East Malling, are described.

Pruning young trees delays their cropping ; leaders must be tipped severely at least once or twice ; reduced tipping should be continued only long enough to produce a tree suitable for its purpose. Thinning out and spur pruning the young trees are described and different treatments for different varieties recommended.

The advantages of pruning bearing trees are related in some detail. Larger and better coloured fruit, easier control of pests and diseases, easier picking, and eventually heavier crops, can all be claimed as the results of pruning.

Methods of thinning and " dehorning " neglected trees are described.

Once this preliminary reconnaissance has been made and the planter has devised a provisional scheme, then we would ask him to let us give our views as to the kind of tree which will suit him best and the most suitable rootstocks for the purpose.

And, if all this meticulous attention to detail is so important in the planning of apple plantations, is it not equally important when we come to consider the planting of soft fruits ?

For the last twenty years our variety trials of soft fruits have pointed to the need for more and more rigid attention to selection of varieties, roguing and control of diseases. Out of these experiments has grown up the Ministry of Agriculture's Scheme for Certification of black currants and of strawberries and the day seems not far distant when other fruits will have to be added to the list of those requiring certification.

With the promised extension of the canning industry looming immediately ahead of us, fruit-growers all over the country will not unnaturally be looking for a lead in the matter of varieties of soft fruits to plant. And this brings us to one of the hardest lessons which we have had to learn from the experiences of the last twenty years, namely, that it is extremely dangerous to broadcast specific recommendations with regard to varieties of soft fruits. For, in spite of the fact that such recommendations have invariably been qualified by the saving clause " under our conditions," this has not sufficed to prevent the planting up on a large scale and under conditions quite different to our own of varieties of soft fruits, such as Baldwin Black Currant which have done well with us and have therefore been well spoken of in our reports.

We have learnt that in the matter of selection of varieties all we can do is to point out the merits and defects of certain outstanding varieties under our conditions, leaving it to the initiative of the individual County Horticultural Officer and the most enterprising fruit-growers in each area to test out from among the " short-list " those which are most likely to succeed under their local conditions.

MYCOLOGY

BACTERIAL CANKER OF PLUM TREES*

By H. WORMALD.

Various possible explanations have been put forward from time to time to account for the damage to plum trees commonly known as "Dieback." It has been attributed to fungi and to unsuitable soil conditions. Recent observations and experiments carried out at East Malling have shown, however, that the chief cause of plum dieback in Kent and other counties is Bacterial Canker. This disease, as the name implies, is caused by a bacterium which infects the stems or branches and produces cankers, and when such cankers encircle the stems or branches the parts above are killed.

A study of the disease at East Malling led to the conclusion that it could not be attributed to unsuitable soil conditions, for the roots of affected trees were almost invariably sound and well developed, and strong shoots often grew out from the rootstock and base of the scion when the upper part of a diseased tree was quite dead. Again, the fact that there was in each case a definite diseased area, or canker, on the stem of a dead or dying tree, suggested attack by a parasitic organism rather than ill-health brought about by defective root action. In the cankers various fungi and bacteria were to be found, but, as the bacteria were generally present at the borders of the cankers and fungi in the older parts, the bacteria were suspected to be the parasites primarily responsible for the damage.

Attempts to isolate the bacteria in pure culture were at first unsuccessful. This result was explained later, when it was found that the bacteria present in the cankers die out during the summer and so cannot be cultured. When isolations are attempted in the spring (April and May), however, the organism can be isolated and cultivated successfully. Eventually, therefore, a bacterium was isolated, which, when inoculated into healthy trees, produced the same symptoms of the disease as observed on naturally infected trees in plantations. Thus definite proof was obtained that the disease was caused by bacterial infection.

The disease may attack maiden trees in nursery rows but it is most noticeable on trees which have been planted out, for it often happens that trees just coming into bearing are killed and have to be replaced by others from the nursery. Trees which have been planted out may make good growth for one or more years, and then, if infection arises, diseased trees die out in the course of a single season. Before the foliage of such trees actually withers there are certain symptoms by which this disease can be recognized. It is important that the grower should note these symptoms for if a tree is so severely cankered that it has to be taken out it should be removed as early in the season as possible.

The Symptoms of Bacterial Canker.

The first outward sign that something is wrong is noticeable early in spring soon after the leaves unfold, when the foliage of affected trees is slightly paler than that of the rest. The difference in tint can only be detected at first by carefully comparing suspected trees with others of the same variety in the vicinity, but later it becomes more

* For more detailed descriptions of this disease the reader is referred to an article published in the *Journal of Pomology and Horticultural Science*, Vol. IX, No. 4, December, 1931, and to a popular account which is to appear in the *Journal of the Ministry of Agriculture*.

pronounced. The leaves of diseased trees are usually slightly narrower than normal and their edges tend to curl upwards. Growth is also checked so that the current year's shoots are shorter and bear fewer leaves than those of normal trees. Thus diseased trees appear to have " thinner " foliage than healthy trees.

A tree showing such symptoms in spring usually dies completely during the summer, the leaves falling early or becoming withered on the trees. The infected part of the stem ceases to grow in thickness ; it thus becomes sunken below the general surface of the stem and is seen as a canker, the edges of which show as ridges which usually run in a direction up and down the stem. A cut made along such a ridge shows a clear distinction between the clean healthy bark and the dark brown infected parts.

Sometimes cankers appear on individual branches ; such branches may show the symptoms described and die without the rest of the tree becoming affected.

The bacterium which causes the cankers lives and multiplies in the stems during the winter and spring but dies out during the summer. As soon as a canker makes its appearance therefore, it does not increase in size, and unless the stem is encircled by that time it does not become girdled later and the tree may recover.

On " maiden " trees in nursery rows the symptoms are very similar except that those trees which are badly cankered make no growth whatever in spring. In some cases that portion of the stem above the canker comes into leaf before withering and the cankered part itself can be recognized by the buds failing to burst on that part of the stem. If the canker does not extend downwards to ground level buds below the canker grow out to form strong healthy shoots.

Losses Caused by Bacterial Canker.

Many complaints have been received from growers concerning the ravages of this disease during recent years, and plots on the Research Station have suffered from it. One of the worst cases observed was in a plantation of Czars at Marden where about 25 per cent. of the trees were cankered in one season.

Victoria and Czar are varieties which suffer severely ; Burbank's Giant Prune is also very susceptible. Of the varieties grown at East Malling, Utility is the only one on which Bacterial Canker has not been observed.

Infection of Leaves, Shoots and Fruit.

The same organism which infects the stems also occurs on the leaves, forming leaf-spots ; occasionally it also infects the young shoots and the fruit. Thus although the bacterium is no longer alive in the stem cankers during the summer months it passes that period on the young growth.

It has been found, by making inoculations during successive months throughout the year, that the stems are liable to be infected during autumn (particularly) and winter, and that they are resistant to infection during the summer. The organism, therefore, spends the autumn and winter in the stem, causing infections which are later seen as cankers, and infects the leaves during spring and summer ; in this way it survives the summer until, in autumn, it is again able to infect the stem.

Control Measures.

Experiments in the control of this disease have not yet proceeded far enough to enable definite advice to be given on measures for checking its spread. The knowledge that has been acquired with respect to the habits of the parasite has led to the hope, however, that control might be obtained by approaching the problem in the light afforded by that knowledge.

Orchard Hygiene.—As the organism is alive in cankers in spring it is suspected that some of the bacteria are carried to the leaves and so start the leaf spot stage. In plantations that have suffered from this disease the trees should be carefully examined early in the spring for the symptoms described, and the infected trees removed and burnt. Care should be taken not to cut back or prune the trees during autumn, for experiments have shown that stems and branches are most susceptible to infection at that time of the year.

Spraying.—Since the organism passes the summer on the leaves, and infects the stems in autumn, it is suggested that Bordeaux mixture should be used for spraying the foliage in summer and the stems in autumn. Spraying the leaves would be more likely to be successful for nursery trees than for older trees in plantations, and for the latter it is recommended that the stems and the bases of the branches be thoroughly sprayed with Bordeaux mixture towards the end of September or beginning of October. At present the autumn spraying seems to be the treatment that might yield the best results, as it could be done thoroughly and without much trouble.

Experiments are on hand at East Malling to test the value of such spraying, but trials elsewhere would also be useful as supplementary evidence. The writer would be glad, therefore, to get in touch with growers who have suffered loss from this disease in their plantations and who are prepared to test autumn spraying of the stems.

" Stem Builders " and " Framework " Varieties.—As certain varieties are far less susceptible to Bacterial Canker than others attempts are being made at East Malling to work the more susceptible but more valuable varieties on stems and branches of the more resistant sorts. In this way it is hoped to build up trees of such varieties as Victoria and Czar with stems and main branches that will be resistant to infection.

Summary.

The symptoms of the disease of plum trees known as Bacterial Canker, a form of " Dieback," are briefly described, and methods are outlined by which attempts are being made to discover means of controlling the disease.

SOME FUNDAMENTAL CONSIDERATIONS REGARDING SUCCESSFUL CONTROL OF APPLE SCAB*

By M. H. MOORE.

The time is rapidly approaching when the measures to be adopted this year for the control of Apple Scab (and Apple Mildew, where this is sufficiently serious) must be considered.

The damage and the financial loss that can result from allowing Scab-infection to assume the upper hand was never more clearly impressed on many fruit-growers than in the 1931 season, when an unusually wet, cold spring and summer provided ideal conditions for infection by the fungus (*Venturia inaequalis*) and for rapid development of the disease. Recently, also, much has been said to urge upon home growers the necessity for increasing the production of sound fruit of high-class quality—an achievement practically impossible where Scab-control is not given the attention it should claim.

Financial loss is usually assessed on a basis of *visible* damage—the familiar fruit-spotting that detracts from the appearance of a sample, which ultimately finds its way into the " C " grade or even into the practically worthless " cull " grade under National Mark standards. The extent of the " *invisible* " damage can only be realized when the results of detailed experiment are examined. It is only when the *loss of crop*, due to Scab-infection, has been assessed, that the full significance of financial loss becomes apparent. There is then no doubt that the damage which can be seen on the mature fruit is only a part of that sustained in all.

Certain detailed records made on Cox's Orange Pippin trees at East Malling Research Station during the past few years, show that many more fruits were consistently produced by trees well sprayed with lime-sulphur than by those not sprayed. Moreover, this initial disadvantage from which unsprayed trees suffered was further aggravated by the loss of a high proportion of the already meagre crop when the fruits were no larger than a fair-sized hazel-nut. When it is borne in mind that a large proportion of the crop eventually brought to maturity is also reduced in value, the effect in one season of failure to control Scab is the more readily appreciated.

It is unfortunately true, however, that this effect is not confined to one season. " Invisible " damage of another nature has to be considered. The Scab fungus attacks the leaves and the young shoots (of certain varieties) as well as the fruits. Heavy infection of the leaves is detrimental to the tree in that it reduces the value of those leaves to that tree. No grower is satisfied when the spray he uses results in leaf-burn ; he knows at once that the efficiency of the leaves has been impaired. Yet the same reasoning applies where Scab is concerned. The experiments to which reference has already been made threw this point clearly into relief. They showed that the succeeding year's crop was prejudiced when the foliage was injured either by spraying (leaf-burn) or by severe Scab-infection. Reduction of leaf-efficiency can thus be translated into

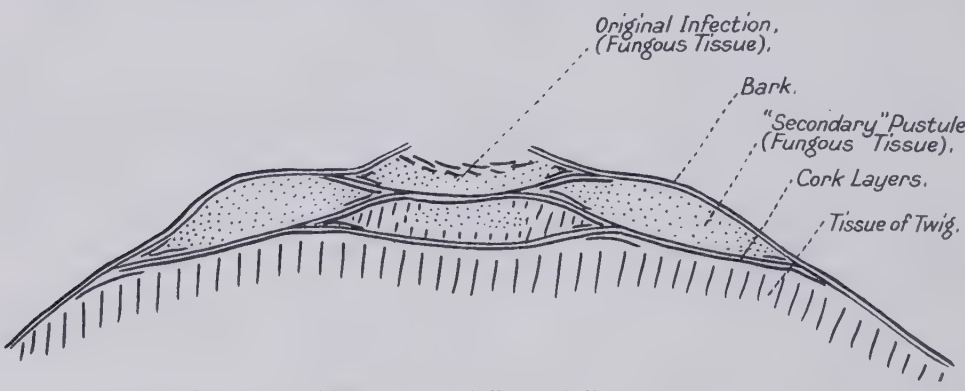
* Reprinted from *The Fruit Grower* of April 7th, 1932, by permission of the Editor, to whom the writer is indebted for the use of the blocks for reproduction of the accompanying photographs and diagram.

terms of the next year's crop. Moreover, when scabbed leaves fall, the fungus goes on developing in them with the ultimate production, in the following spring, of thousands of spores which help to start another year's infections.

In varieties that are susceptible to shoot-infection, such as Cox's Orange Pippin, Worcester Pearmain, Lord Suffield, another means exists whereby the fungus carries itself over from one season to the next. The pads of fungus tissue, or " pustules," which are so often overlooked on the one-year-old shoots, are also instrumental in the production of large numbers of spores in the spring following their formation.

Thus, quite apart from heavy loss of crop, an attack by this disease has a cumulative effect from one season to the next, and such information must be utilized when a Scab-spraying programme is being formulated.

Years ago there was a tendency to lay great stress upon the importance of post-blossom spraying as a primary factor in successful Scab-control. While it would be folly to deny that post-blossom spraying is important and very essential, it has been increasingly evident, during recent years, that pre-blossom applications must be looked upon as the foundation of any sound spraying measures. Indeed, so thoroughly has this point been assimilated, and so violent has been the swing of the pendulum, that it may even be necessary to remind growers that, according to present knowledge, spraying against



Transverse section (diagrammatic) through Scab-" pustule " on Cox's O.P. twig (dormant stage).

Scab while the trees are still dormant would not appear to be necessary, for the beneficial results of such a procedure can, at the most, be very slight. Annual observations of the period of discharge of spores from the dead, scabbed leaves on the ground have shown that maximum spore-discharge coincides with the attainment of a certain stage in the development of the new growth of apple trees with great regularity. It appears that if certain weather conditions arrest the development of tree-growth, the ripening of the main supply of these spores is also arrested. Hence, the maximum discharge at East Malling has always occurred during suitable weather when apple trees in general are nearing, or have actually reached the " pink-bud " stage (see Fig. 1). From " pustules " on young shoots, ripe spores (of a different kind from those discharged from the dead leaves) might be found much earlier in the year, even before the buds have burst. At this time, however, they are (usually) comparatively few in number, and their existence does not justify an application of spray in the dormant season. There is no new growth for them to infect, and, even if they survive until later in the year, they are probably rendered innocuous by a later pre-blossom spraying. Such spores do not constitute the main supply from the twigs. Fig. 2 shows a typical Scab-" pustule " on a one-year-old

shoot of Cox's Orange Pippin, at a stage reached when the buds had burst. In the centre is the original point of infection, and it is from this that spores are produced in the earliest months of the year. This infection began as an ordinary, olive-green, spore-producing Scab-spot in the preceding summer. Later, the fungous tissue grew laterally under the bark and gave rise to two or three " pads " underneath and concentrically around the original point of infection,* as shown by the accompanying diagram. As the spring season advanced, those pads lateral to the primary one split the bark in succession, thus rendering spores liable for release over a considerable period of time. The photograph (Fig. 2) shows how the splitting occurs.

The presence of these " pustules " on the twigs thus becomes of possible importance with regard to early spraying. It will be evident that dormant, or even delayed-dormant, applications of spray can be of no great value in affecting the potency of spores from this source, for the greater part of the fungous tissue is adequately protected by the bark, and the spores cannot be released until the bark splits. It is usual, however, for considerable numbers of spores to be available in the twigs (after splitting has occurred) before those in the dead leaves are ripe. Whether they are released and cause infection depends on the weather. A wet period favours the fungus, for moisture dislodges these spores, when the rosette leaves around the blossom trusses are liable to become infected. It might, therefore, be necessary to apply a protective spray in the " pre-pink " or " green-bud " stage where twig-infection is severe, and spring rainfall is normally heavy. Marsh,† at Long Ashton, has shown that such necessity arises in certain districts in the West and West Midlands of England.

The chief principle to be grasped in spraying against Scab is that the measures are taken as *protection against attack* and not as a means of killing existing infections. Thus it follows that, as the main period of spore-production (and probably of discharge) normally occurs before blossom-time, the foundation of control must be laid then. Such an argument from first principles is more than justified by the results of experiment. Applications of strong fungicides during the blossoming period are not to be recommended, so that, in order to ensure maximum protection for the trees while they are in flower, it is sound practice to cover all the new growth with a fine film of spray applied as near to blossom-time as is convenient, according to particular conditions—that is, in the " pink-bud " stage. Pre-blossom sprays enjoy the advantage that they may safely be used at a greater strength than those applied after blossoming, and it would appear to be good policy to make the " pink-bud " application with spray as concentrated as is generally compatible with safety. For most varieties, lime-sulphur at 1 in 30 can be used, as far as we know, without harm, but not for Stirling Castle, which is extremely susceptible to sulphur-injury This variety should not be sprayed at all with sulphur if it can be avoided. Bordeaux mixture at 8 : 8 : 100 is a remarkably good " scabicide," but it has the disadvantage of being unsafe on a copper-" shy " variety like Cox's Orange Pippin (and probably on several others), even when applied in the " pink-bud " stage. Moreover, it does not control Red Spider or Apple Mildew ; lime-sulphur affords very good control of both. Mildew-attack can sometimes have serious consequences, so that the added safeguard which lime-sulphur affords against this disease is of real benefit, although more serious problems tend to force that of Mildew-control into the background.

The number of pre-blossom applications that should be made is a problem that must be decided after consideration of the facts in every case. Is Scab-infection normally

* See *Journal of Pomology*, VIII, 3 (1930), p. 235.

† Marsh, R. W., Apple Scab-Control in the Bristol Province. *Journal of Pomology*, IX, 1 (1931), p. 69.

of very early occurrence in the district and would it be too risky, therefore, to delay the first application until the " pink-bud " stage is reached ? Is the acreage to be covered a very large one ? Have the trees previously been neglected ? Is there considerable infection on last year's twigs ? The answers to such questions as these must decide the issue. If they are in the affirmative, the case for two applications (or, in the event of a large acreage to be covered, for commencing operations prior to " pink-bud ") is certainly strengthened. Nevertheless, it must be stated here that the necessity for two at East Malling has not been established, although the experimental results have been obtained on Cox's Orange Pippin, a variety practically without peer for twig-infection. This is, however, as much a special case as any other, and cannot therefore be demonstrated as absolute or final.

Fig. 3 illustrates the stage at which the " pre-pink " application might usefully be made ; a spray of the same strength as that used at " pink-bud " can be employed.

Post-blossom applications have long been the cause of considerable discussion as to the strength of spray to use. Experimental evidence obtained here shows that, provided the " pink-bud " spraying is thoroughly done, post-blossom sprays of much weaker concentration are able to carry on the work of protection, even in the most adverse weather conditions. Thus, lime-sulphur, prepared at a dilution as great as 1–100, or even 1–150, gives successful results *when preceded by a thorough " pink-bud " application at* 1–30. Colloidal sulphur at 4 lb. per 100 gallons, and sulphur dusts have also successfully been used when similarly preceded by this stronger spray.

Dusting with sulphur would appear to be a useful adjunct to wet spraying ; it saves a great deal of time and labour, and is especially valuable in providing continued protection for, perhaps, a short period when it is inconvenient to spray. Nevertheless, an interplanted arrangement of apple varieties presents great difficulty where such as Lane's Prince Albert, Stirling Castle, Newton Wonder, Belle de Boskoop and Rival are included, for they are all liable to drop their leaves and fruits when dusted, post-blossom, with sulphur. In spraying, trees of such sulphur-sensitive varieties need not receive direct application, and but little spray-" drift," but this procedure of " missing " trees obviously would be impossible in dusting on a large scale. Hence, economically, dusting might be out of the question in many instances. Tests with sulphur dusts are as yet in the experimental stage in this country, but indications are already forthcoming that it would generally be unwise to rely entirely upon them for good Scab-control—a wet spray would appear to be highly desirable, at least pre-blossom.

From the fungicidal point of view, field tests have shown that lead arsenate can be incorporated with lime-sulphur, so that the spray becomes a combined insecticide and fungicide. Indeed, the evidence strongly suggests that the combined spray may be somewhat more beneficial than otherwise as a fungicide.

With regard to the use of a spreader, opinions are very conflicting. There appear to be few critical field data which throw any light on this vexed question. The most that can be said at present is that a spreader promotes even distribution of spray-fluid over surfaces that otherwise probably would be difficult to cover evenly, and it is a great asset where spraying has to be done on a windy day. Its presence also eases the actual delivery of spray from the nozzles. Whether its inclusion increases the potency of fungicides with which it is used is as yet unproved. " Spray gelatine," at 1 lb. per 100 gallons, has been used in the routine Scab-spraying at East Malling for the past few years, when the general " cleanliness " of the fruit was quite satisfactory.

The number of post-blossom applications to be made depends largely on the type of season. Many growers have regretted that they ceased spraying against Scab too early in 1931, a season in which an extra summer application would have made all

FIG. 1.

"Pink-bud" stage in the Apple.

FIG. 2.

Showing typical splitting of Scab-"pustule" in one-year-old shoot of Cox's O.P.

FIG. 3.

"Green-bud" stage in the Apple.

FIG. 4.

"Petal-fall" stage in the Apple.

the difference between the production of " Fancy " and of " Extra-Fancy " fruits. However, it is generally safe to say that an application of spray at petal-fall (see Fig. 4) and again about three weeks later, should, together with the pre-blossom, provide more than a normal " commercial " control in most cases. Where post-blossom dusting is pursued, it would be advisable to make applications a little more frequently.

It must not be forgotten that spraying is not the sole aid to Scab-control. Such operations as pruning, manuring and grassing-down are being investigated according as they affect Scab-incidence. Pruning and grassing-down were undoubtedly beneficial in this respect on established trees at the Research Station in 1930 and 1931, but the effect of manuring appears to depend very largely on weather conditions.

It is impossible, in the scope of a brief review of the problem of Scab-control, to deal at length with the complex reactions that these different factors exert upon one another. A delicate balance appears to exist in the relationship between " tree-condition," the cultural practices adopted, and the weather conditions. Unsuitable cultural practices would tend to upset this balance, with the result, perhaps, that the tree temporarily becomes more Scab-susceptible. Hence, spraying measures that otherwise would be successful might prove to be inadequate under these conditions. The problem is by no means a simple one, and only further investigation can reveal the full significance of each little cog in the wheel, and, perhaps, point the way to making the utmost use of it in efforts made towards better production.

Summary.

This brief review of some of the more important aspects of Apple Scab-control directs particular attention to the serious loss that can be caused by the disease, and means are suggested whereby it might be avoided.

Certain points in the life-cycle of the fungus (*Venturia inaequalis*) are discussed in their bearing on the time of application of sprays for the control of the disease. Spraying *for protection against attack* is strongly urged, and the value of a " pink-bud " application is emphasized. Weak post-blossom sprays can successfully be employed where the " pink-bud " application has been thoroughly made. The number of spray-applications to make is discussed with regard to the particular conditions existing.

The significance of factors governing " tree-condition," and the bearing this may have on the ultimate results of spraying, are pointed out.

ENTOMOLOGY

A SIMPLE METHOD OF FORECASTING INSECT ATTACKS IN ORCHARDS PREVIOUS TO THE SPRAYING SEASON

By A. M. MASSEE.

The problem of insect pest control in commercial fruit orchards during the spring months is still a very difficult one. This fact may be accounted for in many ways. For example, while it is admitted that the tar-distillate winter washes are very valuable for controlling such pests as the Apple Sucker and the various species of Aphides on top and soft fruit, these winter washes do not control the leaf eating caterpillars of the Winter Moth group very efficiently. Not even when the winter wash is applied at the strength of 10 per cent. The same applies to the winter petroleum washes. Some insect eggs are destroyed by these oil sprays, but many important pests, i.e. Aphides and Apple Sucker are not affected and spring washes must be used where these insects occur.

Apart from the fact that some insects are not destroyed by winter washing it must be remembered that certain fruit pests must necessarily be controlled by contact and stomach poison sprays applied in the spring. Some of the more important of these are as follows : Apple Sawfly, Fruit Tree Red Spider, Apple and Plum Case Bearers, Apple Leaf Skeletonizer, Tortrix Moths, Apple Pith Moth, Clouded Drab and many others.

The control of certain insect pests in the winter months by means of a winter wash is comparatively simple because there is a long period during which the spray can be applied, and the weather factor does not enter into the picture to any great extent.

The spring spraying programme presents a more difficult problem. The time for spraying is very limited, and for example, if an arsenical wash is to be applied to achieve the maximum success the spray must be applied at the correct time. If applied a few days late a great deal of damage may have been caused to the fruit trusses. It is often difficult to apply the spring washes at the ideal time owing to a rainy period, or a break down of the spraying machinery, or to some other cause.

For the above reasons it is essential to know as soon as possible where outbreaks of any particular pest may occur in the plantations so that the grower can be prepared to spray the orchard concerned at the correct time.

It has been the practice for some growers to spray established apple and cheery grass orchards with a 10 per cent. tar-distillate winter wash ; this operation plus grease-banding, it was thought, would be sufficient to reduce " caterpillar " to such an extent that spring arsenical washes would not be required.

Frequently, however, it has proved to be necessary to apply a spring arsenical wash, in spite of the application of the tar-distillate ; and it has often been noticed that a great deal of defoliation has occurred in orchards as the result of caterpillar outbreaks, the damage being sufficient to demand the application of a lead spray. This is just one typical example where a forecast of an insect attack would be welcomed.

A forecast of potential insect outbreaks, i.e. caterpillar epidemics, can be obtained quite readily. This is achieved by the simple process of obtaining a representative collection of shoots furnished with well developed spurs, and forcing them into early growth by placing them under the influence of heat, etc. Such material should be

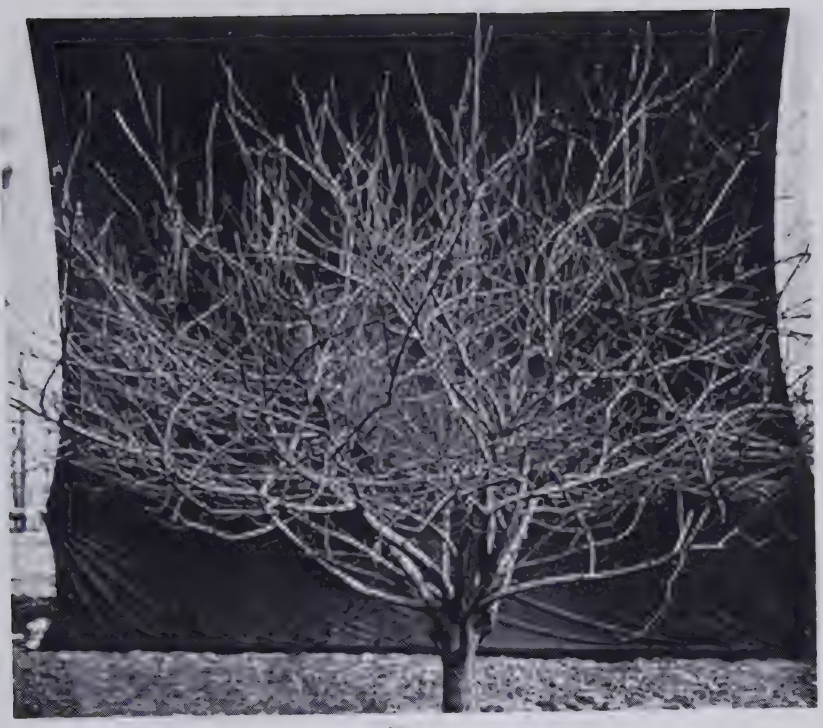


Fig. 1.

Unpruned Tree.

Fig. 2.

Tree Thinned and Dehorned.

THE PLANTING SITUATION

By N. B. BAGENAL.

As the Research Station embarks upon the twentieth year of its existence, it is a temptation to take a glance at a few of the salient points in regard to Planting which have emerged during the lifetime of the Station whilst, at the same time, looking forward to the future. Naturally, the first subject which arises is in regard to rootstocks.

Twelve years ago, when making our first planting of trees on different " Paradise " stocks, there was some question as to whether 15 feet was not too much space to allow between the trees. We now know that some kinds of so-called " Paradise " stock require considerably more space than is provided by a 15 foot square plant, and to the planter of the future we should say " Plant at distances which your rootstock requires," or conversely, " Choose a stock which will suit the space you require to be filled."

We would even go further and say, as a result of our experiments, that trees on some stocks will give better crops than trees on certain other stocks, even though the trees may be the same size. This " qualitative " difference in cropping may be just as important as the quantitative difference in growth referred to above, and we should therefore add this further point for planters : " Choose a stock which will give the best crop for the size of tree required."

The second lesson which experience has taught has been with regard to the planning of the orchard or plantation. Today all our research knowledge concerning manuring, cultivation and spraying, every single factor in the production of good fruit suggests grave difficulties in the mixed plantation, and it would probably be logical to conclude from our own experience that the ideal plant should consist of separate blocks, each containing only one kind of fruit, but in two or three varieties. The usual criticism of this idea is that the grower does not want to put all his eggs in one basket and that it is merely wasting space not to put something in between the tree fruits to crop while they are growing. Unfortunately the saving effected in space by mixed planting may be ultimately outbalanced by the limitations to good management which this system involves. For instance, with regard to manuring, our experiments have shown that good management of black currants under our conditions consists mainly in applying heavy dressings of nitrogenous manures, whereas in the case of apples it would appear that heavy nitrogenous manuring, in the absence of potash, may entirely upset the balance of the tree. If, therefore, apples are interplanted with black currants, the grower is faced from the beginning with a manurial dilemma. How can he give the best manurial treatment to both crops when each requires a different proportion of nitrogen to potash ?

Another point in connection with the mixed plantation is the necessity which often arises of having to spray at different times with different kinds of washes. Even when it is possible to apply the same wash at the same time, it often happens that what is the best strength of wash for one kind of fruit may be quite unsuitable for the other, and vice versa.

As an example of the dangers of mixed planting, in this connection, one might instance our Quince Stock Trial where bush pear trees on different quince stocks were interplanted with gooseberry bushes. In this case the main incompatibility between the two crops lay in the direction of spraying requirements, for, whenever it was found

necessary to spray the pear trees in the spring with lime-sulphur or lead arsenate, either separately or in combination, the spray falling on the young berries proved equally undesirable whether in the form of lime-sulphur or lead arsenate, so that in the end we were left with the uncomfortable alternative of having to discontinue the use of both these sprays on the pears or run the risk of producing an unsaleable crop of gooseberries.

Bearing such cases in mind, are there any concrete recommendations which it would be reasonable to make to future planters with regard to mixed plantings? Of the fruits which are reasonably compatible in regard to their manurial and spraying preferences, the most obvious combinations would appear to be plums and black currants, morello cherries and black currants, and loganberries or blackberries and black currants. So far as apples, gooseberries, red currants, raspberries and strawberries are concerned, we should say that, whilst combinations of any of these fruits are possible, they are likely to succeed better when grown separately.

When apples are interplanted with gooseberries, red currants or strawberries, spraying difficulties are sure to arise sooner or later either in regard to the strength of tar distillates to be used or to the risk of damage from the use of lime-sulphur or lead arsenate.

On the whole, one might say that if small fruits are to be planted between apple trees, the most suitable undercrop from the point of view of the apples would be either gooseberries, red currants or strawberries. On the other hand, for the reasons already indicated above in these three cases the undercrop might be expected at times to suffer from the spraying programme accorded to the apples.

Turning now to the consideration of the form of tree most suitable for future planting, what has experience taught in the last twenty years? Here, at any rate in regard to apples, all the arguments would appear to favour the use of the high bush form of tree as opposed to the half-standard or standard.

Twenty years ago the use of the standard tree was generally advocated for planting at from 30 to 40 feet over so-called "filler trees" and small fruits with a view to a gradual change-over from a mixed plantation to a grass orchard during a period of from fifteen to twenty years. Today, many of these twenty-year-old grass orchards present a formidable spectacle. In many instances the trees are altogether too large to allow of efficient management, with the result that the grower has either to be content with irregular crops of second and third grade apples, or he has to spend a great deal of money in order to produce regular crops of good fruit. This is especially true of those areas where the dreaded capsid-bug is rampant.

Lastly, in cases where only one variety was planted in the permanent rows, the problem of cross-pollination very often becomes acute upon the removal of the fillers and cases could be quoted in which healthy specimens of such reputedly self-fertile varieties as Bramley's Seedling have had to be headed back and top-grafted with other sorts before cropping again becomes normal. For all these reasons then, it seems that the future for apple culture lies with the bush tree rather than with the standard.

As to which is the most paying form of bush plantation, permanents on vigorous stocks interplanted with fillers on dwarfing stocks, or all permanents on either vigorous, semi-dwarfing or dwarfing stocks, these are questions of the utmost importance to the planter, but unfortunately they are questions which cannot be satisfactorily answered without a full knowledge of local conditions.

For this reason our advice is to go very fully into such matters as soil, aspect, rainfall and market varieties that suit the district. In these matters the County Horticultural Officer is always at hand to help with first-hand experience of local conditions.

collected from different parts of the orchard. This should be done systematically by first obtaining the spurred growths from trees around the outside of the orchard, then by walking diagonally across the orchard and collecting material on the way. By this means random sample of shoots will be obtained. Not only is it essential to select the shoots from different parts of the orchard, but it is equally important to select the material from different parts of the trees. Some from spurs situated low down, some as high up as possible and some from the centre of the trees. Shoots of 18 inches or 2 feet in length have proved to be ideal for this purpose. All shoots must be carefully labelled to denote their position in the orchard.

The twigs are then arranged in glass jars containing sand and water, and are placed in some warm sheltered spot, such as a greenhouse or on the window ledge of a window facing south. Naturally, a heated greenhouse is best of all. Some few days later the buds begin to open and many of the spurs are forced into growth very rapidly.

In addition to the growth being formed some weeks earlier than under natural conditions in the orchard, the insect population on the twigs and shoots also develops correspondingly earlier, and thus it is possible to forecast such attacks as " Caterpillar " Aphis or Sucker some weeks ahead, and be prepared to deal with the outbreak at the proper time.

About the second week of February has been found the best time for collecting the shoots of apples, pears, plums and cherries. If collected at this date most of the fruit buds flower in the normal way. Apple shoots must not be collected too early in the year if normal flowering is required.

It is advisable to spray the shoots lightly with water by means of a hand syringe or an atomizer every other day, and of course it is necessary to keep the jars filled with water. The bases of the stems should be cut occasionally to allow the water to pass up easily, and to remove any fungus growth which may be growing on them.

This method of forecasting attacks of insect pests has been tried out for several years now, and it has proved to be very helpful in suggesting a reliable programme for pest control.

In one instance it was possible to forecast a serious outbreak of caterpillar in a cherry orchard, while in an apple orchard near by, on the same farm, Apple Capsid Bugs were noted to hatch out on forced shoots some weeks before their normal time. In this case the grower did not realize that the Apple Capsid Bug existed in the orchard, but having obtained this knowledge, he was able to get the trees greasebanded and was fully prepared to tackle the problem when the time arrived for carrying out spraying operations.

By a similar method it is also possible to forecast when the routine lime-sulphur spraying for the control of the Black Currant Gall Mite should be carried out. It is known that the spray should be applied at the height of the migration period, which is sometime towards the end of March or in April. In practice growers have been advised to apply the spray just before the flowers open, but unfortunately this is not always the ideal time.

However, it is possible to obtain the correct date of spraying by using the following method. Collect a number of black currant shoots infested with typical " big-buds," those with " big-buds " at the apex of the shoots for preference, and place them in a jar containing sand and water. The jar should then be placed on a window sill outside the house, or in a position that is not too warm, but under natural conditions. The " big-buds " should be examined from time to time by means of a hand lens with a magnification of not less than eight times, and when the mites are found to be swarming on the outsides of the " big-buds " then the bushes in the plantation are at the correct stage

for spraying. It has been found that the time of migration of mites on the cut shoots does not vary from that under normal conditions provided the cut shoots are kept away from artificial heat.

It may be of interest to note that one fruit grower in north Kent has collected sample shoots from his orchard for many years, and by placing them in jars in a heated greenhouse, it has been possible to obtain a clear conception of the pests in the various orchards over some 600 acres of fruit.

Summary.

Details are given of a method which has been found satisfactory for forecasting insect attacks in fruit orchards. It is demonstrated that by being able to forecast attacks of certain injurious insects, growers can prepare their spraying programme in advance of the spring spraying season, which is very limited.

THE CONTROL OF THE RASPBERRY AND LOGANBERRY BEETLE BY MEANS OF DERRIS

By W. STEER.

The Raspberry Beetle (*Byturus tomentosus* Fabr.), often referred to in error as a "weevil," is the most serious pest of raspberries and loganberries and is often troublesome on cultivated blackberries.

The damage it causes is familiar to most growers and consists of :

(1) the destruction of the flower buds by the adults in May
(2) the production of small misshapen fruit by the feeding of adults and larvæ and
(3) maggoty fruit.

The presence of larvæ or grubs in the fruit is most serious, and results in greatly reduced market value and substantial loss in weight.

LIFE HISTORY.

In May, adult beetles emerge from the soil. These are about one-sixth of an inch long, at first yellowish-brown but later becoming greyish-brown, and may commonly be seen feeding in various flowers, such as hawthorn and apple, or eating the flower buds of raspberries and loganberries. They pair and lay their eggs in the blossoms and on the young fruits of raspberries, loganberries and blackberries. Egg-laying begins early in June and continues into July. Hatching begins towards the middle of June.

After hatching the tiny larvæ crawl over the surface of the berries for some time and eventually burrow in, usually at the base. They tunnel in the "plug" and feed on the surrounding flesh. When fully fed they leave the fruit and enter the soil, where they turn to pupæ and, subsequently, to adult beetles, and remain till the following May.

RESULTS OF EAST MALLING SPRAYING TRIALS.

When work on this pest was begun at East Malling in 1927, the only method of control which gave promising indications was that evolved by Lees and Peren at the Long Ashton Research Station. This consisted of three sprayings of arsenate of lead, given when approximately one-third, two-thirds and all the blossom were fully open.

Observations on the habits of the pest suggested that the number of spray applications recommended by these workers (i.e. three) might be reduced by directing the attack against the larvæ rather than against the adult beetles. It was found that after hatching the larvæ do not enter the plug immediately, but crawl over and often feed upon the surface of the berries for some considerable time. It was thought, therefore, that the pest might prove vulnerable in its early larval stages if only a toxic deposit could be provided on the young berries. Lead arsenate, although efficacious, was found to leave a dangerous arsenical residue on the ripe fruit, and soon had to be abandoned in favour of a non-arsenical spray (Derris).

In 1928 a single application of spray just before hatching began reduced the infestation considerably on raspberries, but it was obvious that more than one

application would have to be made to ensure a " commercial control." In subsequent work, therefore, two sprayings were given, the object being to spray just before the beginning of hatching and again after an interval of about ten days.

In every year except one, good results have been obtained with a proprietary Derris preparation containing soap. In 1929 the results were rather indifferent, possibly because the Derris material used had been in stock for a long time.

Last season's results were particularly encouraging; two sprayings of Derris reduced the average infestation of loganberries from 66.3 to 14.6 per cent., and of raspberries from 78.3 to 5.6 per cent. On loganberries this treatment nearly doubled the total weight of the crop, and increased the proportion of marketable fruit in a badly infested plantation from 23.8 to 77.7 per cent. (see diagram). This meant an increase in *marketable fruit* at the rate of over two tons (from 8.3 cwts. to 51.8 cwts.) per acre. The average number of loganberries per pound of ripe fruit over the whole of the picking season worked out at 176 on unsprayed and 127 on sprayed plots.

A home-made Derris dust costing about 15s. per cwt. has given promising indications on both raspberries and loganberries, but so far the best results have been obtained with the above mentioned proprietary mixture of Derris and soap used as a wet spray.

COST OF SPRAYING.

The following figures are from the actual costings of a 4 acre piece of Lloyd George raspberries growing on the Station.

Two commercial sprayings were given, using a 2½ h.p. machine supplying six nozzles at a pressure of about 150 lbs. Two days were taken to spray the 4 acres and 2,000 gallons of spray were used on each occasion.

The cost per application was as follows :

		£	s.	d.
Spraying	6 men, 15 hours at 9d.	3	7	6
Mixing, etc.	1 man, 15 hours at 9d. ..		11	3
Carting Water	1 man, 6 hours at 9d.		4	6
	1 horse, 6 hours at 5d. ..		2	6
Petrol	3 gallons at 1s. 3½d.		3	10½
Spray Material	100 lbs. at 2s. 1½d.	10	12	6
Water	2,000 gallons		7	0
	Total (4 acres)	15	9	1½
	Cost per acre	£3	17	3½

As two sprayings were given the total cost per acre was £7 14s. 7d., exclusive of wear and tear of machinery. Of this £5 6s. 3d. represents the cost of spray material alone. The particular material used was a somewhat expensive preparation containing Derris Root and soap. Should cheaper forms of Derris prove just as effective, the cost per acre could be very considerably reduced.

Where the length of the rows is not unduly long some saving might be made on the cost of application by using a horse-drawn power machine supplying two nozzles. It is hoped that investigations now in hand may also lead to a considerable reduction in the cost of spraying.

No exact figures are available for loganberries, but with a similar outfit the cost of application would probably be about the same as for raspberries.

SUGGESTIONS FOR CONTROL MEASURES.

Although the investigations have not yet reached their final stages, it is considered that the results so far obtained warrant the recommendation of the use of a Derris wash.

Spray Material.

Finely-ground Derris root can be obtained, but is often of uncertain quality. At present it is, perhaps, more conveniently purchased in a proprietary form from reliable insecticide merchants. Such a preparation may or may not require the addition of soap, and, generally speaking, should be used at a strength not less than that recommended by the makers for use against caterpillars and other chewing insects. It is advisable always to use fresh material and to avoid buying Derris which has been in stock for any length of time.

When to Spray.

Loganberries.

First application ten to fifteen days after the first flowers open.

Second application about ten days later.

(At East Malling these dates are on the average about June 10th and 20th.)

Raspberries.

First application about ten days after the first flowers open.

Second application seven to fifteen days later.

(At East Malling these dates may generally be reckoned as June 10th-15th and June 20th-25th.)

Blackberries.

As no detailed trials have yet been made on blackberries definite recommendations as to the number of applications and time of spraying cannot be made, but the following tentative suggestions may prove useful :

Veitchberry. Spray third or fourth week in June and ten to fifteen days later.

Himalaya Berry and Parsley Leaved or " Cut-leaf " Berry. Spray end of June and ten to fifteen days later.

These varieties are usually fairly clean in the later pickings, even when the infestation is severe.

King's Acre. Spray fifteen to twenty days after the first flowers open and again about ten days later. This early variety, which is often seriously infested, should be sprayed at the same times as the loganberry.

How to Spray.

It is essential to wet all flowers and fruits thoroughly by driving the spray into the base of the bloom. This does not necessarily imply drenching, but can be accomplished by means of a fairly fine spray provided a little care is taken. Raspberries of average vigour require about 500 gallons of wash per acre ; loganberries usually need one-half to two-thirds gallon per plant.

Summary.

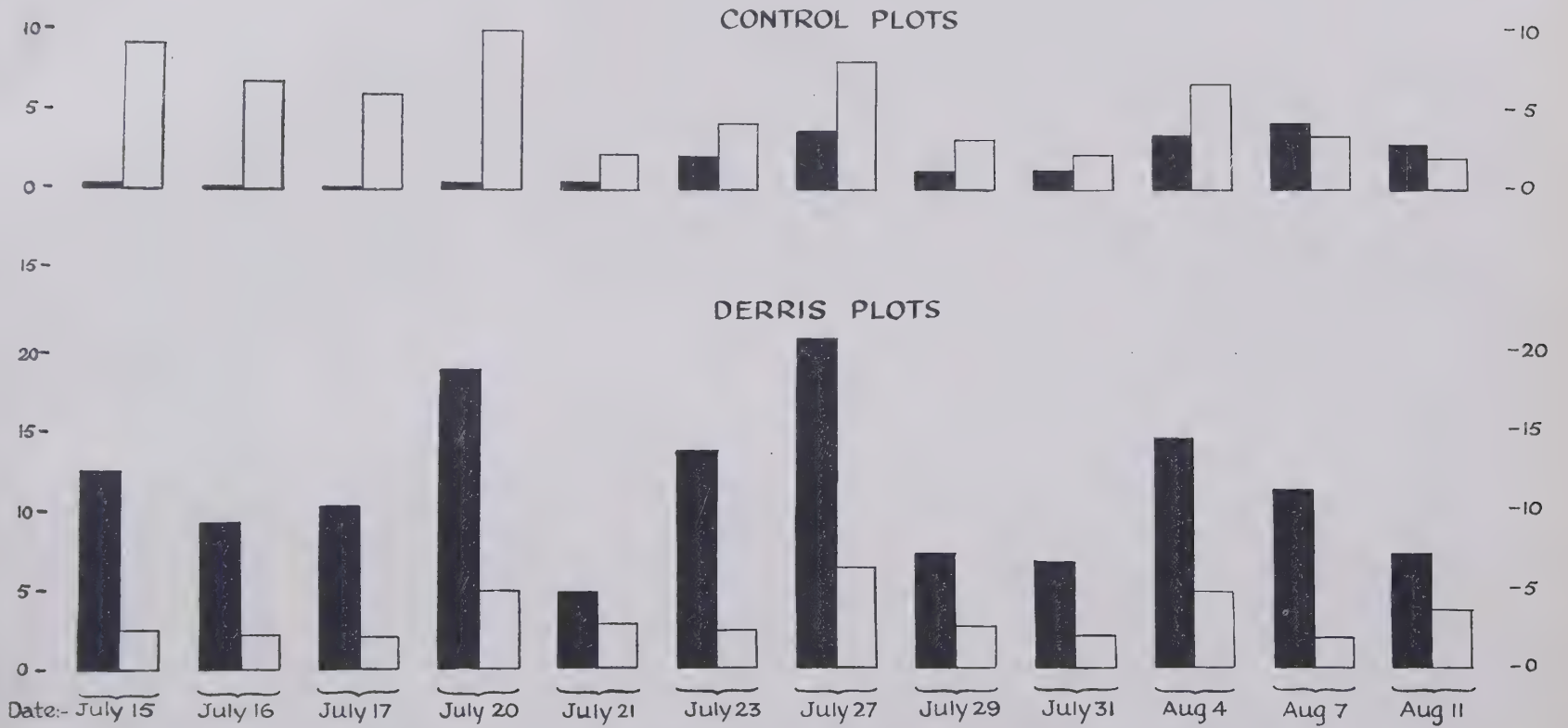
The habits of the pest are briefly described and mention is made of observations which first suggested the possibility of attacking it in its early larval stages.

Experiments in which two applications of a proprietary Derris preparation gave very promising results are briefly reviewed.

The cost of spraying is discussed and suggestions made for suitable times for spraying with Derris.

DIAGRAM 3

Trial I - Comparative yields as shewn by twelve commereial piekings.



Shaded columns represent weight of marketable fruit in LBS.

Unshaded " " " " unmarketable " " "

PUBLICATIONS

LIST OF PUBLISHED REPORTS FOR THE YEAR COMMENCING 1ST JANUARY, 1931 TO 31ST DECEMBER, 1931.

	TITLE.	JOURNAL OF PUBLICATION.	REPRINTS.
	POMOLOGY.		
	TOP FRUITS.		
	Root stocks.		
	Apples.		
E45.	The Elimination of Sources of Error in Field Experiments. The Standardization of Fruit Tree Stocks. *R. G. Hatton.*	East Malling Res. Sta. Ann. Rep. for 1928-1930. (April, 1931.) (II—Supplement.) 13-21.	Price 3d. Postage 2d.
E52.	The Influence of Vegetatively raised Root stocks upon the Apple, with Special Reference to the part played by the Stem and Root portions in affecting the Scion. *R. G. Hatton.*	Journ. of Pom. and Hort. Sci. (December, 1931.) .. .. **9.** 265-277.	Price 2s. 8d.
	Peaches.		
E44.	Peach Stock Trials. *A. W. Witt and R. J. Garner.*	East Malling Res. Sta. Ann. Rep. for 1928-1930. (April, 1931.) (II—Supplement.) 22-31.	Price 5d. Postage 2d.
	Plums.		
E46.	An Experiment in the Thinning of Victoria Plums. *A. C. Painter.*	East Malling Res. Sta. Ann. Rep. for 1928-1930. (April, 1931.) (II—Supplement.) 74-82.	Price 4d. Postage 2d.
E48.	An Experiment in Plum Thinning. *A. C. Painter.*	East Malling Res. Sta. Ann. Rep. for 1930. (April, 1931.) (I—General.) 68-73.	No Reprints.
	Cherries.		
E50.	Some Aspects of Morello Cherry Culture. *N. H. Grubb, A. C. Painter and H. Wormald.*	Kent Cherry and Soft Fruit Show Catalogue. (July, 1931.) 15-24.	Price 2d.
	Experimental Technique.		
E47.	Field Experiments in Horticulture. *T. N. Hoblyn.*	Imp. Bur. Fr. Prod. Tech. Com. No. 2. (March, 1931.)	Price 2s.
E49.	Recording Apparatus for Horticultural Experiments, including Automatic Counting Devices. *W. S. Rogers.*	East Malling Res. Sta. Ann. Rep. for 1928-1930. (April, 1931.) (II—Supplement.) 65-73.	Price 4d. Postage 2d.
E54.	The Technique of Horticultural Experiments. *T. N. Hoblyn.*	Rothamsted Conf. XIII. The Tech. of Field Expts. (May, 1931.) 42-49.	Price 1s. 6d. To be obtained from Rothamsted Expt. Stn., Harpenden, Herts.

TITLE.	JOURNAL OF PUBLICATION.		REPRINTS.
SMALL FRUITS.			
RASPBERRIES.			
Esf15. The Cropping of Raspberry Varieties at East Malling. *N. H. Grubb.*	East Malling Res. Sta. Ann. Rep. for 1928-1930. (April, 1931.) (II—Supplement.) 32-45.		Price 3d. Postage 2d.
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